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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXVIII] MAY 15, 1942 [No. 1

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Some Physico-Chemical Properties of the System Water-Thallous Formate

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Department of Chemistry, University of Kansas

ABSTRACT: The following properties of aqueous solutions of thallous formate have been measured over a wide range of concentrations and at temperatures between 0° and 60° C; density, viscosity, surface tension, electrical conductivity and solubility. A comparison of these properties with the properties of salt solutions in general, shows that solutions of thallous formate are characterized by a greater density and solubility than solutions of most salts containing an inorganic ion.

I. INTRODUCTION

THALLOUS formate is a white crystalline salt which is characterized by its low melting point of 94° C. and its high solubility in water—about eight grams of the salt being soluble in one gram of water at room temperatures. The solutions are clear and colorless or of an amber hue, depending upon the concentration and upon their age. The more concentrated solutions gradually darken upon standing and finally become almost black, especially if they are exposed to light. This change in color is due to the fact that the salt is light-sensitive and turns tan and finally brown upon exposure to light.

The concentrated solutions are quite fluid and may have a density of more than three grams per cubic centimeter at room temperature. These two properties make the solutions useful for the determination of the density of minerals—a use to which they have been adapted by Sullivan (1) and Clerici (2). Aside from the work of these two men, no studies have been made upon the physical properties of thallous formate and their investigations are very limited in this direction. A few of the properties of solutions of other

thallous salts have been studied by other investigators from time to time and will be introduced later in this paper for comparison.

The present paper is concerned with five of the more important physical properties of thallous formate solutions—densities, electrical conductivities, viscosities, and surface tensions as functions of concentration and temperature—and with its solubility. Measurements were made upon five solutions varying in concentration of solute from ten to eighty percent. The measurements were also made at five temperatures varying from 0° to 60° Centigrade. In the case of the eighty percent solution, determinations could not be made at 0° due to the fact that such a solution is supersaturated with respect to the solute. It should be emphasized that this paper is not a report on the conventional properties of dilute solutions, so frequently encountered in the field of physical chemistry, but upon the properties of solutions, none of which are dilute, and many of which are extremely concentrated.

II. PREPARATION OF MATERIALS

Thallous formate was obtained from two sources. Part of the salt was prepared from thallium metal and another part was obtained from the Eastman Kodak Laboratories. The latter sample was of a light-green color and was purified by recrystallization before use.

The preparation of thallous formate from the metal can be carried out in a number of ways. A simple method consists of first converting it into thallous hydroxide. This can be done by placing shavings of the metal in an evaporating dish and adding enough water to almost cover the metal. If part of the metal is left exposed to the air the metal is gradually converted into thallous hydroxide by the action of the oxygen of the air and of the water. The thallous hydroxide can then readily be converted into the formate by treating it with formic acid. The excess of formic acid can be removed by evaporation at 100° C. This method serves very well, but it requires much patience and time to prepare the thallous hydroxide.

Another method which may be used to prepare the thallous formate is to convert the metal into the sulfate by heating it with sulfuric acid. The sulfate is then treated with an equivalent quantity of barium hydroxide. Barium sulfate is precipitated and can be removed by filtration, leaving thallous hydroxide in solution which can then be converted into the formate with formic acid. By this method either barium formate or thallous sulfate remains in a small

amount as an impurity which is difficult to remove by recrystallization.

A third method, and probably the most satisfactory, consists in using the thallium metal as the anode in an electrolytic cell with a carbon cathode. A small amount of sulfuric acid is added as an electrolyte and a large current is passed through the cell. By using a high current-density at the cathode the thallium is deposited as a spongy mass of metal. It is then washed with water and treated with formic acid. The thallium in the spongy state is readily attacked by formic acid to form thallous formate.

All three methods were used in the preparation of thallous formate and produced products which could not be distinguished by their melting points. However, the method last described was the most satisfactory.

The melting point of the salt was taken as a criterion of purity. References differ as to its melting point. *Beilstein,* and the *International Critical Tables* give a melting point of 95° C. whereas Sullivan (1) found a melting point of 94° C. The samples used in the present investigation melted at 93.5-94° C. Since different samples of the salt gave results which agreed within the limits of other experimental error, the purity of the samples was assumed to be sufficient.

Distilled water was used in making up all solutions except for conductivity and surface tension measurements, in which case conductivity water was used. In the case of the conductivity measurements the same sample of conductivity water was used for preparing the standard potassium chloride solutions (for the standardization of conductivity cells) and for the preparation of the solutions.

III. DENSITIES OF THALLOUS FORMATE SOLUTIONS

Density determinations were made by the use of a Parker pyknometer (3), which was standardized at each of the temperatures of measurement with distilled water. The volume of the pyknometer capillaries was determined by filling each with mercury, weighing the mercury, and calculating the volume. In calculating the density of the solutions, account was taken of the buoyant effect of the air in making the weighings.

The average values of the densities from two independent determinations are given in the following table:

TABLE I

Conc. of Solution	Densities of Thallous Formate Solutions				
	0° C	20° C	30° C	45° C	60° C
0 percent	0.9998	0.9982	0.9957	0.9902	0.9832
10 percent	1.0927	1.0902	1.0878	1.0804	1.0730
20 percent	1.2033	1.1994	1.1946	1.1882	1.1795
40 percent	1.5033	1.4950	1.4893	1.4801	1.4693
60 percent	1.9849	1.9727	1.9644	1.9509	1.9374
80 percent	.....	2.8679	2.8549	2.8358	2.8152

A general equation for the variation of the density of any one solution with temperature may be determined from the above table. The familiar equation is of the form:

$$D_t = D_o + at + bt^2 + \ldots$$

where D_t is the density at temperature t, D_o is the density of the solution at 0° C., and a and b are constants. By substituting two values of D_t and the corresponding values of t from the above table, two equations are obtained which may be solved simultaneously for a and b. By doing this, using t as 30° and 60°, the following equations are obtained for water, 20 percent thallous formate, and 60 percent thallous formate:

For water,

$$D_t = .9998 + .0000033t - .0000047 4t^2.$$

For the 20 percent solution,

$$D_t = 1.2033 - .00029t - .0000178t^2.$$

For the 60 percent solution,

$$D_t = 1.9849 - .00068t - .00000150t^2.$$

Similar equations for the other solutions may be obtained in the same manner.

Likewise it is possible to determine the equation for the variation of density with concentration of solute at any one temperature. The equation is of the usual form

$$D_x = D_o + ax + bx^2 + cx^3 + \ldots$$

where D_x is the density at any concentration x, D_o is the density at zero concentration, *i. e.*, density of the solvent, and *a*, *b*, and *c* are constants. Below is given the equation for the variation of density with concentration at 20° C. The constants were calculated from the densities of the 10 percent, 40 percent, and 80 percent solutions in Table I. The concentrations are expressed in grams of solute per 100 grams of solution, *i. e.*, percent of solute.

At 20° C.,

$$D_x = .9982 + .009078x - .0000116x^2 + .0_5238x^3.$$

Similar equations may be obtained for the solutions at other temperatures in the same manner.

The density-temperature behavior of these solutions is quite similar to most aqueous solutions of electrolytes. There is a gradual increase in the temperature coefficient in going from dilute to concentrated solutions and also in going from low to higher temperatures.

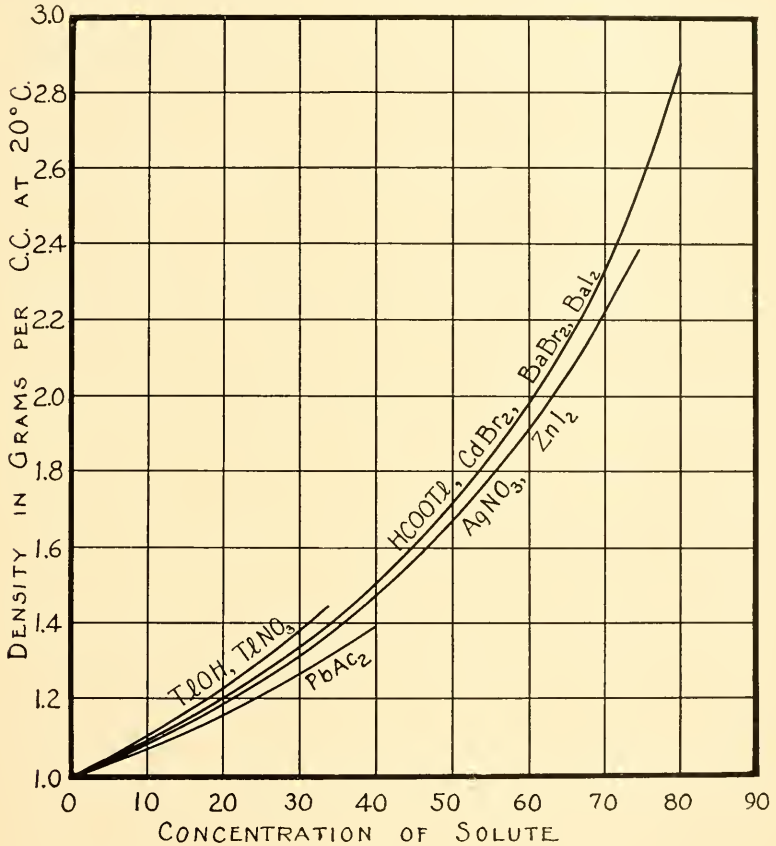

FIG. I.

The variation of density with concentration at 20° C. in indicated in Fig. 1. Here again the form of the curve is quite normal as compared to other salt solutions, as can be seen from the concentration-density curves for several other aqueous solutions of inorganic salts included in the figure. (4) This group of curves show two interesting facts. First, the curve for thallous formate is identical with the curve for barium iodide and bromide and cadmium bromide. The

densities of these four salt solutions at 20° coincide within 0.1 percent over the entire range of their solubilities. Data for cadmium bromide was found for solutions containing forty percent solute and for the barium salts the data was extended up to sixty percent solutions. The agreement at other temperatures is not quite as good but is of the order of 0.5 percent. In the second place, only two salts were found whose solutions had higher densities than thallous formate solutions at a given concentration and these two salts were both salts of thallium, namely, thallous hydroxide and thallous fluoride. Most concentration-density curves lie below the curve for thallous formate.

IV. VISCOSITIES OF THALLOUS FORMATE SOLUTIONS

The viscosities of the solutions were determined with an ordinary Ostwald viscosimeter; the instrument being calibrated with water at each of the temperatures used. In order that the height of the liquid column would be the same in every case, the same volume of liquid was used in each determination. The times of flow were taken with a stop-watch which was read to one-tenth of a second. The watch was checked with an electric clock and was found to agree within one part in six hundred. Readings were taken until several values checked within 0.1 to 0.3 seconds, a precision which was usually not difficult to attain.

In using the Ostwald viscosimeter the viscosity of the liquid in question is proportional to the density of the liquid and to the time of flow, thus

$$\eta = k\,D\,t$$

where η is the viscosity, D is the density, t is the time of flow, and k is a constant characteristic of the instrument and depending upon the size and length of the capillary and upon the volume of liquid which flows through the capillary.

If η, D, and t represent the viscosity, density, and time of flow of the unknown liquid, and η_w D_w, and t_w represent the corresponding values for water, then the relative viscosity of the unknown liquid referred to that of water is given by the expression.

$$r = \eta/\eta_w = kDt/kD_wt_w = Dt/D_wt_w$$

The relative viscosities obtained in this way may be changed to absolute viscosities by multiplying by the absolute viscosity of water at the temperature in question. Therefore,

$$\eta \text{ (absolute)} = \eta_w dT/D_w t_w$$

where η_w is the absolute viscosity of water. The above equation is not strictly true unless the time of flow is quite large and the difference in viscosity between the unknown liquid and water is small. In the present case these conditions are fulfilled sufficiently to warrant the use of this equation.

Below are given the experimental data obtained in the determination of viscosities of the thallous formate solutions.

TABLE II

Relative Viscosities of Thallous Formate Solutions

Conc. of Solution	0°	20°	30°	45°	60°
0 percent	1.0000	1.0000	1.0000	1.0000	1.0000
10 percent	1.020	1.047	1.055	1.065	1.088
20 percent	1.050	1.080	1.097	1.131	1.161
40 percent	1.150	1.237	1.270	1.346	1.386
60 percent	1.491	1.610	1.684	1.770	1.810
80 percent	.....	2.930	2.966	3.006	3.042

TABLE III

Absolute Viscosities of Thallous Formate Solutions
(millipoises)

Conc. of Solution	0°	20°	30°	45°	60°
0 percent	17.94	10.09	8.004	5.970	4.699
10 percent	18.31	10.56	8.44	6.36	5.10
20 percent	18.84	10.89	8.78	6.75	5.46
40 percent	20.64	12.48	10.18	8.04	6.50
60 percent	26.79	16.24	13.49	10.57	8.51
80 percent	.....	29.58	23.75	17.91	14.30

All electrolytes, excepting a few salts of potassium, rubidium, caesium and ammonium, increase the viscosity of water. In most cases the change in viscosity is not large even in the more concentrated solutions. There are a few exceptions to this statement, notably calcium chloride and zinc chloride solutions. The latter has a relative viscosity of 153 for a solution containing 75 percent salt at 25° C.

The change of viscosity of thallous formate solutions with concentration is similar to that of most electrolytes, the viscosity increasing slowly at low concentrations and very rapidly at higher concentrations as may be seen by a study of Figure II. The viscosity of most solutions of electrolytes lies above that of thallous formate solutions of the same concentrations as can be seen from the same figure which includes representative values for several salts. (5)

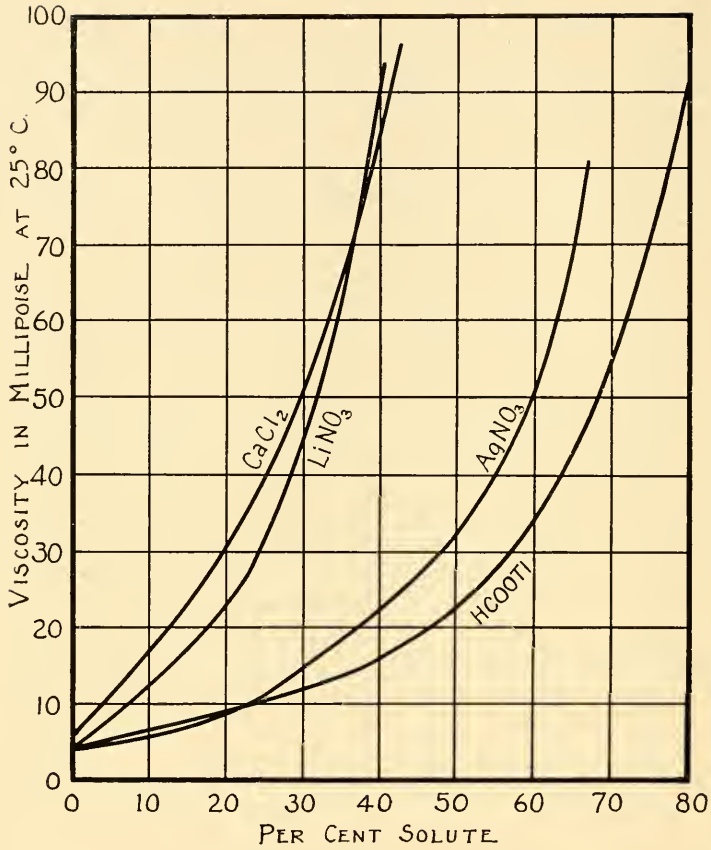

FIG. II.

The change of viscosity with concentration can best be expressed by an equation of the form

$$\eta_x = \eta_o + ax + bx^2 + cx^3$$

where η_x is the viscosity of the solution of concentration x, η_o is the viscosity of the pure solvent, and a, b, and c are constants. The constants may be evaluated from known values of the viscosities at three concentrations. At 20° the equation is

$$\eta_x = \eta_o \times .0666x - .002555x^2 + .0000596x^3.$$

This equation was calculated from known values of the viscosity of ten, forty, eighty percent solutions and fits the curve well except in the neighborhood of the sixty percent solutions where it agrees only within 10 percent. This agreement is fair considering the wide range

of concentrations to which it is applicable. A more exact equation might be obtained over a smaller concentration range.

The variation of the viscosity of thallous formate solutions with temperature resembles the variation of the solvent itself as may be seen in Figure III. Changing the concentration of the salt does not alter the general form of the curve to an appreciable extent.

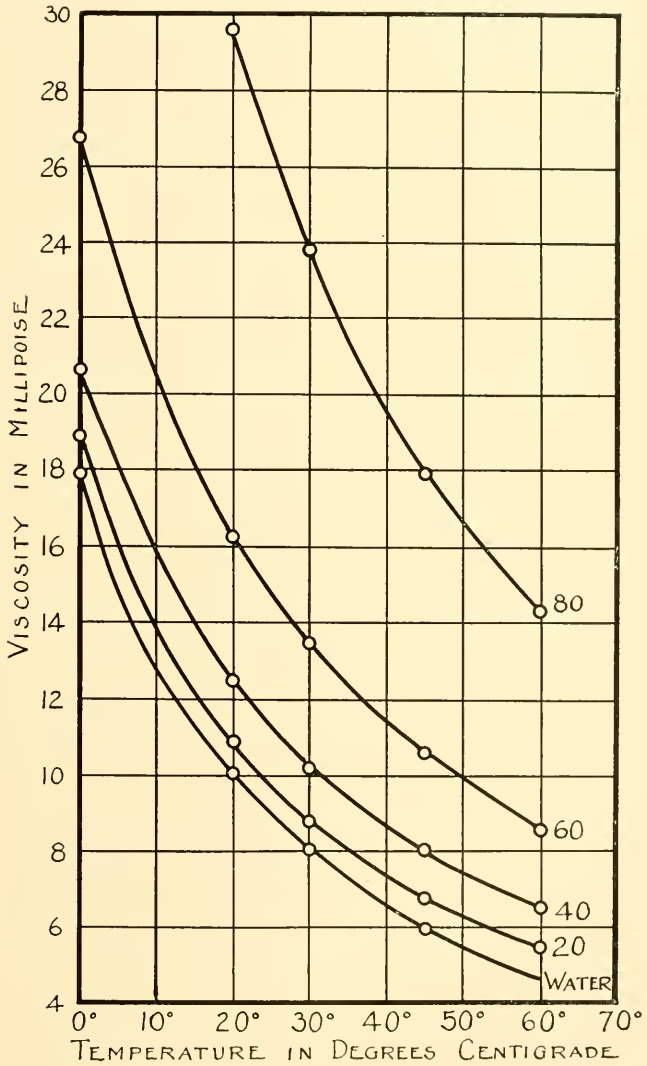

Fig. III.

The variation of viscosity with temperature can best be expressed by an equation of the form

$$\eta_t = \eta_o/(1 + at + bt^2)$$

where η_o is the viscosity at 0° C., η_t is the viscosity at temperature t, and a and b are constants. By evaluating these constants from the viscosities at 20° and 45°, the following equation was determined for the twenty percent thallous formate solution:

$$\eta_t = \eta_o/(1 + .03388t + .0001317t^2)$$

This equation holds well up to 50° C. and within 4 percent up to 60° C.

V. CONDUCTIVITIES OF THALLOUS FORMATE SOLUTIONS

Conductivity measurements were made by the Wheatstone bridge method. An alternating current of 1,000 cycles per second was used which was obtained from a triode vacuum tube oscillator. A radio-tube amplifier was used to increase the sensitivity of the measurements. The minimum in the bridge was detected by means of a set of phones tuned to the 1,000-cycle frequency.

The conductivity measurements were made with two cells of similar design; a third cell was also used of somewhat different construction. The first two cells had the advantage of having stationary electrodes and there was little danger of the distance between them changing. The third type, with adjustable electrodes, had the advantage of being easily washed and dried and did not require as much solution as the other two cells. All three cells were designed for use with high-conducting solutions and for small amounts of solution. The cell constant of each was determined at each temperature by standardizing it with a potassium chloride solution of known conductivity. The precision of measurement was only of the order of one percent, but this should also be the order of accuracy of the measurements since different cells and different samples of the salt were used, all of which gave results agreeing within one percent of each other. Also with the last cell, the Wheatstone bridge arrangement was changed whereby the amplifier was eliminated, without any detectable change in the values of the conductivities.

For the determination of the cell constant of cells 1 and 2 a solution of potassium chloride containing 7.4790 grams of potassium chloride per 1,000 grams of water was used. For the third cell, due to its higher cell constant, a solution containing 76.628 grams of potassium chloride per 1,000 grams of water was used. In each

case the cell constant gradually increased with temperature due to expansion of the glass. To obtain a better value of the constant it was plotted as a function of temperature and a smooth curve drawn through the points. Values lying on this curve were taken for the cell constants at each temperature, thus giving a "smoothed" value for the constant. In only one case did the "smoothed" value differ from the experimental value. The experimental data for the determination of the cell constant of the cells follows:

TABLE IV

Cell Constants of the Three Conductivity Cells

Cell No. 1		Cell No. 2		Cell No. 3	
Temperature	Cell Constant	Temperature	Cell Constant	Temperature	Cell Constant
0° C	17.45	0° C	23.52	0° C	42.00
20° C	17.61	20° C	23.66	20° C	42.65
40° C	17.78	30° C	23.72	30° C	42.50*
60° C	17.96	45° C	23.82	45° C	43.38
.....	.....	60° C	23.92	60° C	43.80

Having obtained the cell constants of the cells it is possible to determine the specific conductance of any solution by dividing the cell constant by the resistance of the cell filled with the solution whose conductivity is to be measured.

Table V gives the average values (two independent measurements) for the specific conductivities for the various solutions at the various temperatures:

TABLE V

Specific Conductivities of Thallous Formate Solutions, mhos.

Conc. of Solution	0°	20°	30°	40°	45°	60°
80 percent	....	.184	.224	.263	.285	.347
60 percent	.123	.188	.227	.254	.277	.339
40 percent	.0885	.136	.164	....	.203	.242
20 percent	.0447	.0708	.0850	....	.107	.131
10 percent	.0228	.0367	.0443	....	.0562	.0693
5 percent	.0119	.01936	.0235	....	.....	.....

The equivalent conductance, which is a more useful quantity, can be calculated from the specific conductance and the density and concentration of the solution. The equivalent conductance is equal to the product of the specific conductance by the volume of solution containing one gram equivalent of the solute. Thus, if d represents the density of a solution containing p percent of solute, then the

* This value seems to be in error and a "smoothed" value of 42.92 was used in its place.

volume of solution containing one gram equivalent or 249.4 grams of thallous formate, is given by the relation,

$$\text{Equivalent volume} = \frac{100 \times 249.4}{d\ p}.$$

Therefore the equivalent conductance is

$$= \frac{100 \times 249.4 \times \text{spec. cond.}}{d\ p}.$$

The equivalent conductivities of the solutions so calculated are given in the following table:

TABLE VI

Equivalent Conductivities of Thallous Formate Solutions, mhos

Conc. of Solution	0°	20°	30°	40°	45°	60°
80 percent	.....	19.99	24.47	28.81	31.33	38.41
60 percent	25.74	39.65	48.09	54.03	58.99	72.78
40 percent	36.73	56.66	68.70	.....	85.50	102.8
20 percent	46.31	73.72	88.68	.....	112.3	138.6
10 percent	52.05	84.00	101.8	.....	129.7	161.2
5 percent	56.83	92.38	112.3	.....	.....	.....

Figure IV shows the variation of the equivalent conductance with concentration and temperature for the solutions studied. The variation of conductance with temperature (at a given concentration) is that to be expected of a normal electrolyte. The conductivity rises quite rapidly with increasing temperature over the temperature range considered. Most aqueous solutions of electrolytes show an increase in conductivity with temperature at first and a decrease at higher temperatures—that is, the conductivity-temperature curve goes through a maximum. The position of this maximum depends upon the concentration of the solute and occurs at lower temperatures for the more concentrated solutions. (6) The temperature of maximum conductivity was not reached in the measurements upon thallous formate as it probably lies well above 200° C.

The relation between the equivalent conductance of the solutions and the logarithm of the equivalent dilution at individual temperatures is the most important feature shown in Figure IV. The curves are similar to those for most electrolytes in water, the equivalent conductivities tending toward a maximum at infinite dilution. Measurements were not made on sufficiently dilute solutions to determine the maximum equivalent conductance with much accuracy. It appears to be of the order of 65 mhos at 0° C., 110 mhos at 20° C.,

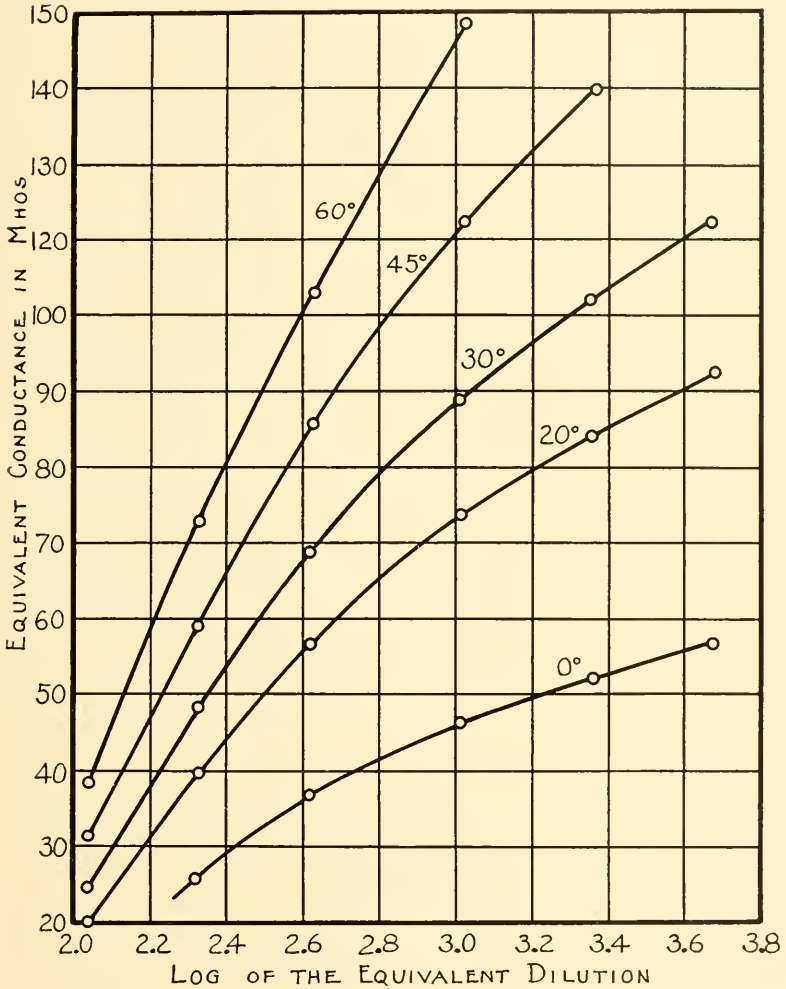

FIG. IV.

and 195 mhos at 60° C.* Data in the *International Critical Tables* (7) give an ionic conductance of 63.5 mhos for the thallous ion and 47 mhos for the formate ion at 18° C. This value would correspond to an equivalent conductance of 110.5 mhos for thallous formate at 18° C. and infinite dilution.

Another interesting factor brought out by Figure IV is that it shows that the conductance ratio decreases with increasing tempera-

* Obtained by plotting the equivalent conductance as a function of the square root of the normality and extrapolating to zero concentration.

ture. Thus for any given concentration, the low temperature curves approach more closely to the maximum value of equivalent conductance than the high temperature curves. This agreement means that at a given dilution the conductance ratio is greater at low temperatures than at higher temperatures.

VI. SURFACE TENSIONS OF THALLOUS FORMATE SOLUTIONS

The measurement of surface tension presented the greatest difficulty in the present study. The first attempts to make the measurements were made by the ring method of du Noüy. The results so obtained appeared to deviate markedly from the results with the capillary rise method, and since the latter method is known to give more reliable values, the ring method was discarded. It might be mentioned that the ring method indicated a slight rise in surface tension with concentration of solute at low concentrations—in agreement with the capillary rise method. However, at higher concentrations the surface tension by the ring method at first decreased slowly, and then above sixty percent solute, the surface tension fell rapidly to about two-thirds the value of water at a given temperature.

The capillary rise method did not serve as satisfactorily as might be desired, especially at high concentrations. The accuracy of the method is limited by the accuracy of measurement of the capillary rise. For the eighty percent solutions the density is three times that of water with a capillary rise of only one-third of that of water. Consequently the relative error of measurement is three times as great for the concentrated solutions as for water. The capillary rise for water varied from about 30 to 55 millimeters, depending upon the size of the capillary, and could be determined within about one millimeter. This determination corresponds to an error of 1-2 percent for water. For the more concentrated solutions the error is increased to about 5 percent.

The variation of surface tension with temperature was small, but appeared to be a linear relationship within the error of measurement. It was considered that the variation with concentration was the more important factor and measurements were made only at 0°, 30°, and 45° C. Measurements were made on pure water and six solutions of varying concentration from five to eighty percent solute. Four different capillary tubes were used. They were first examined for uniformity of bore and then their diameters were determined by

filling them with mercury and determining the weight of the mercury. In case of deviations of results with different capillary tubes, the results with the smallest capillary were taken as the best values due to the fact that the accuracy of measurement was greater with a smaller capillary tube.

The following series of data were obtained for the determination of the surface tension by the capillary method.

TABLE VII

Surface Tensions of Thallous Formate Solutions, dynes per cm.

	Concentration of Thallous Formate						
Temperature	Water	5%	15%	25%	50%	70%	80%
0° C	72.5	....	....	73.5	76.6	....	74.5
30° C	71.0	71.8	72.8	72.3	74.2	76.2	74.5
45° C	66.3	....	....	70.1	70.6	....	72.1

The surface tensions fall with rising temperature and show a gradual increase with increasing concentration of the solute. At low concentrations—up to about forty percent solute—the relation is linear, but at higher concentrations the surface tension rises more rapidly. This phenomenon is common to the majority of salt solutions. It is to be expected from the fact that the surface tension of the pure fused salts is often very much higher than the surface tension of the fairly concentrated solutions.

It is apparently a hitherto unnoted fact that the increase in surface tension of aqueous solutions, as compared to water alone, depends largely upon the valence type of the salt, if the salt is a strong electrolyte containing inorganic ions only. Thus for nine mono-monovalent salts listed in the *International Critical Tables* (8) the surface tensions of 1 M solutions at 20° C. have an average value 1.3 dynes higher than water alone; 1 M solutions of five di-valent salts at 20° C. have an average value of 1.9 dynes higher than water alone; and 1 M solutions of nine mono-divalent salts at 20° C. have an average value 2.8 dynes higher than water alone. Solutions containing appreciable concentrations of H^+ or OH^- show abnormal variations from this rule and even in the case of certain other salts, effects due to the individual character of the ions are observable in any one valence class. Ammonium salts show, for example, the most marked deviations from the above averages. When the data is examined for thallous formate, the increase in surface tension is approximately normal for salts of its valence type. A 1 molal solution is roughly equivalent to a twenty weight percent solution of thallous formate. Interpolation of data in Table VII would give as

an increase in surface tension at 30° (over that of water alone) a value of 1.5 dynes. (Although the data for other salts given above corresponds to a temperature of 20° C., the value of the increase in surface tension—from the data available—is the same at 30° C.)

It may be stated that the apparent fall in the surface tension above 70 percent, as shown by the data in Table VII, is probably in error. Though the 80 percent solution was checked with three capillary tubes, only one solution was used and it may be that some impurity was present in this solution. The measurement at 70 percent was carried out quite carefully and the value so obtained is probably more reliable than the values obtained with the 80 percent solution. Such a fall in surface tension of the solution is out of line with the general behavior of salt solutions with regard to surface tension.

VII. SOLUBILITY OF THALLOUS FORMATE IN WATER

The solubility of thallous formate in water at various temperatures was determined by the freezing point method. The most satisfactory method consisted in placing a solution of known composition in a large test tube fitted with a stirrer and thermometer, freezing the mixture and then allowing the temperature to rise very slowly until the solid phase just disappeared. The data so obtained could be duplicated quite readily and was used to determine the complete temperature-composition phase diagram for the system thallous formate—water.

In determining the diagram, four series of measurements were made as follows: (1) Measurements on solutions prepared by diluting weighed quantities of a solution of known concentration; (2) measurements upon a series of solutions made up independently and used only for one determination at one concentration; (3) and (4) measurements made by placing a weighed quantity of salt in a test tube and alternately adding weighed quantities of water and determining the freezing point over a range of concentrations. The second series of measurements was introduced to be certain that there would be no error in measurements due to error in the concentration of the solutions. However, the values on all series of measurements checked very well, except for two values in the first series which were later found to be in error due to too rapid warming of the solutions after freezing them.

The eutectic point could be determined without difficulty by using a solution of the approximate composition of the eutectic mixture and freezing it. While the phase in excess was separating out the

temperature would fall gradually until the eutectic point was reached at which point the temperature would remain constant for a considerable length of time, even if left in the freezing bath. After the contents of the tube had become solid the temperature would again begin to fall. In this way the eutectic temperature could be determined quite easily. No attempt was made to measure directly the composition of the eutectic mixture since it could be obtained from the phase diagram within about 0.2 percent. The composition of the eutectic obtained in this manner was 70.2 percent thallous formate.

The data obtained are given below:

SERIES I:

	A	B	C
Concentration of solute	= 89.3%	67.0%	63.4%
Freezing point	= 27.05°	—16.0°	—14.0°

SERIES II:

	A	B	C	D	E	F	G
Concentration of solute	= 0%	5%	10%	20%	40%	60%	80%
Freezing point	= 0.0°	—.5°	—1.2°	—3.0°	—6.4°	—11.9°	1.9°

SERIES III:

	A	B	C	D
Concentration of solute	= 74.9%	71.27%	66.8%	61.28%
Freezing point	= —9.1°	—15.6°	—14.6°	—12.3°

SERIES IV:

	A	B	C	D
Concentration of solute	= 92.7%	84.9%	80.45%	78.47%
Freezing point	= 45.0°	14.6°	2.9°	—1.7°

Freezing point of thallous formate = 94° C.

The complete phase diagram is shown in Figure V. The diagram is of very simple form, showing only one eutectic and no formation of hydrates. The diagram is strikingly similar to the diagram for silver nitrate except for the facts that the eutectic of the latter occurs at about fifty percent silver nitrate and the melting point of the silver nitrate is much higher than for thallous formate.

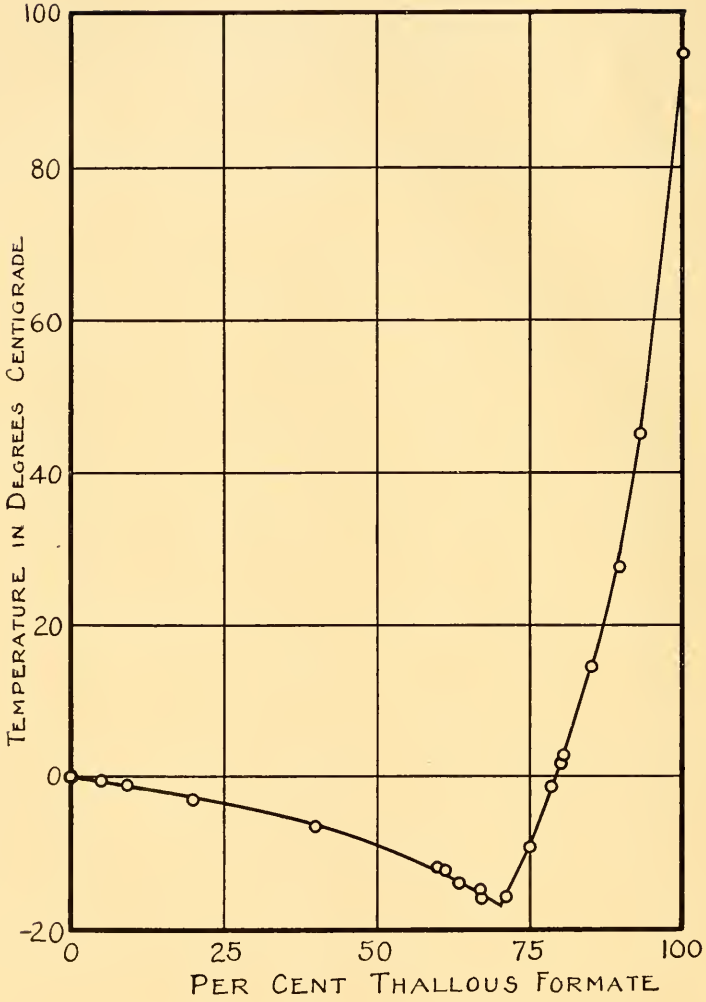
100
80
60
40
20
0
-20
0
25
50
75
100
TEMPERATURE IN DEGREES CENTIGRADE
PER CENT THALLOUS FORMATE

FIG. V.

VIII. GENERAL SUMMARY

In reviewing the physico-chemical properties of thallous formate solutions in relation to other aqueous solutions, three distinctions might be pointed out.

First, the densities of the thallous formate solutions are greater than the densities of the majority of aqueous solutions. This property may properly be ascribed to the thallous ion inasmuch as the formate ion would not produce abnormally dense solutions. Perhaps if one considered a number of salts of the heavy metals, similar to thalium, this distinction would not be so great. At least the fact that thallium lies well down the list in the periodic table would suggest that solutions of its salts would be fairly dense compared to other solutions.

Second, the thallous formate solutions are characterized by their low viscosities. This again may in part be ascribed to the thallous ion. A few salts such as salts of potassium, caesium, rubidium, and ammonium lower the viscosity of water. Jones and Veazey (9) ascribe this property to the unusually large atomic volumes of these elements. In this respect thallium has an atomic volume which is probably above the average, though it is much lower than the atomic volumes of the elements mentioned above. According to Jones and Veazey the larger ions would slide past one another with less friction than smaller ions. Their view is not strongly supported, but might furnish an explanation, in part, for the low viscosities of thallous formate solutions.

One of the most outstanding properties of the thallous formate solutions is the high solubility at ordinary temperatures. One might again ascribe this property to the presence of the anion inasmuch as formates and acetates possess, in general, a high solubility. However, it also appears that thallous salts, in general, seem to have fairly high solubilities. The hydroxide, sulfate, cyanide, fluoride, nitrate, and acetate are all quite soluble in water. Such a wide variety of soluble salts is noteworthy, especially if one considers the solubility of the corresponding silver and lead salts, since thallium resembles these two metals most closely in its physical and chemical properties.

One further factor may be considered—a comparison of the conventional degree of ionization calculated from freezing point data with the conductance ratio of thallous formate in aqueous solution. The so-called degree of dissociation may be determined by the freez-

ing point method or by conductivity measurements. At 0° C. the degree of ionization should not differ appreciably from the degree of dissociation at the freezing point of the solution, since the temperature at which the solution freezes is only a few degrees below zero except for the concentrated solutions.

The degree of ionization is also given approximately by the ratio of the conductivity of the solution in question to the conductivity at infinite dilution—if one assumes the original theory of ionization to be correct. A correction for viscosity may be made by multiplying this ratio by the relative viscosity of the solution. The equivalent conductance at infinite dilution at 0° is approximately 67 mhos. Representing the degree of ionization by α, the following results are obtained:

Conc. of Solution	α (no viscosity correction)	α (with viscosity correction applied)
5 percent	.848	.857
10 percent	.777	.793
20 percent	.692	.726
40 percent	.548	.630
60 percent	.384	.572

Let us now consider the degree of ionization from the freezing point data. If we let c be the number of mols of thallous formate in 1,000 grams of water and α be the degree of ionization then there will be $2c\alpha$ mols of ion and $c(1-\alpha)$ mols of nondissociated salt which act in lowering the freezing point. Since each mol lowers the freezing point of 1,000 grams of solvent by 1.86° C., we have the following relation:

$$\Delta T = \text{freezing point lowering} = 1.86(1+\alpha)c$$

or
$$\alpha = \frac{\Delta T}{1.86c} - 1$$

Further, the molality, c, is equal to $\frac{1000\ x}{(1-x)\ 249.4}$ where x is the weight fraction of thallous formate in solution and 249.4 is the molar weight of thallous formate.

Therefore

$$\alpha = \frac{\Delta T(1-x)249.4}{1860\ x} - 1$$

Using this equation the following values are obtained for the degree of ionization of thallous formate:

Conc. of Solution	Freezing Point Depression ($\triangle T$)	Degree of Ionization
5 percent	.65° C	0.660
10 percent	1.35° C	0.628
20 percent	3.15° C	0.688
40 percent	6.55° C	0.318
60 percent	12.05° C	0.078

There seems to be an increase in the degree of ionization in going from the ten to the twenty percent solution. Undoubtedly this increase is due to experimental error inasmuch as an error of 0.1° will produce a marked change in the values of the degree of ionization obtained by this method. An error of this amount in the freezing point is quite possible and is the best explanation of the increasing ionization with increased concentration of solution. Aside from the one discrepancy noted, the "degree of ionization" for the various solutions is quite normal. The degree of ionization falls quite rapidly with increasing concentration. Again it is quite similar in behavior to solutions of silver nitrate. The latter decreases in "ionization" from practically complete ionization in a solution containing 0.17 percent silver nitrate to zero ionization in a solution containing about 33 percent silver nitrate. (10)

However, the very considerable discrepancy—at a given concentration—between a calculated from conductance data and from freezing point data, especially in the more concentrated solutions of thallous formate, is but another contribution to the criticism of the original Arrhenius theory of ionization that has accumulated in the past thirty years. Following modern conceptions of the behavior of strong electrolytes in solution, it is probable that thallous formate is completely dissociated at all concentrations and the variations of a with concentration (from conductance data) are due to changes in ion mobility with concentration and that variations in "a" from freezing point data are due to the influence of the ion atmosphere—resulting in the so-called activity of the ions—upon the colligative properties of these solutions.*

* Reviews of the criticism of the Arrhenius theory may be found in any modern textbook of physical chemistry. See, for example, Millard, *Physical Chemistry for Colleges*, 5th edition, New York, 1941, pp. 253 and 264.

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A New Bog-lemming (Synaptomys) from Meade County, Kansas

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ABSTRACT: A new bog-lemming, *Synaptomys cooperi paludis* nov. subsp. is described from Meade county, Kansas. The type and eighteen paratypes were collected from a bog area in association with *Sigmodon hispidus, Peromyscus maniculatus, Reithrodontomys megalotis* and *Crypotis parva.*

THE Kansas University Museum of Vertebrate Paleontology has been collecting vertebrate fossils in Meade county, Kansas, during the past six summers. Since the vertebrates obtained have been chiefly Upper Pliocene and Pleistocene mammals, we have endeavored to make a thorough study of the recent mammalian fauna for comparison with the Pleistocene faunas of that region.

Feces of *Synaptomys* were observed during the summers of '37, '38, and '39 in the bog areas situated in the Meade County State Park. During these summers attempts to collect the lemming ended in failure, since the traps were sprung by cotton rats. Cotton rats are abundant in the area throughout the meadows, weed patches along the streams, and in the bogs. The only trap used was the "Museum Special" snaptrap which was not large enough to hold the cotton rats. When entering the area the summer of '41, a new effort was made to collect the lemming. A large series of snap rat traps was obtained to catch out the cotton rats from the bog area. Examination on the seventh of July of the bog area showed abundance of cuttings and feces left by the lemmings. A trap line of 400 traps was put out around the edge of the bog, nearly every other trap being a rat trap. The first evening the traps were set, a number of *Sigmodon hispidus* were caught before the trap line was completed. The traps were run and baited three times each day during the first five

days. In the first twenty-four hours beginning July 7, seventy-six *Sigmodon* were taken. In two weeks more than 200 *Sigmodon* had been removed from the area. After the first five days the "Museum Special" snaptrap was moved into the best areas of the bog for trapping of the lemming. Over a period of nineteen days beginning July 8, twenty-one specimens of *Synaptomys* were taken, of which two were females. These have been compared with the other races known in North America and have been found to differ appreciably from the other forms.

We are greatly indebted to the following persons: Messrs. Ralph Taylor, Henry Setzer, Jack Twente and Henry Hildebrand, members of the field party, who helped to trap the above series of specimens; to Mr. Lee Larrabee, chairman of the Kansas State Fish and Game Commission, Mr. John Carlton and Mr. Leonard Sutherland of Meade County State Park for permission to study in the area and for courtesies shown our party; also to the following persons for the loan of specimens used in the study: Mr. C. D. Bunker, curator, University of Kansas Museum of Birds and Mammals, Lawrence, Kan.; Dr. W. H. Burt, curator of mammals, Museum of Zoölogy, University of Michigan, Ann Arbor, Mich.; Mr. E. A. Goldman, of Biological Survey, Division of Wildlife Research, Washington, D. C.; Mr. J. LeRoy Kay, curator vertebrate paleontology, Carnegie Museum, Pittsburgh, Pa.; Mr. Woodrow Goodpaster, Cincinnati Society of Natural History, Cincinnati, Ohio; and Dr. G. C. Rinker of Hamilton, Kan.

The new bog-lemming may be designated as *Synaptomys cooperi paludis* subsp. nov.

Holotype.—Male adult, skull and skin, No. 13713, collection of Kansas University Museum of Mammals: collected by Claude W. Hibbard, July 12, 1941, from the bog area surrounding brooder pond No. 1, Meade County State Park, fourteen miles southwest of Meade, Meade county, Kansas.

Paratypes.—Nos. 13708, adult male; 13709, immature male; 13710, adult male; 13711, adult male; 13712, immature male; 13714, immature male; 13715, immature male; 13716, adult male; 13717, immature male; 13718, subadult male; 13719, adult male; 13720, adult female; 13721, immature male; 13722, immature male; 13723, adult female; 13724, adult male; 13725, immature male; 13726, immature male.

Distribution. — Known only from bog areas found in Meade County State Park (see discussion).

Diagnosis. — Larger than *Synaptomys cooperi gossii* (Coues) Measurements in millimeters of type: total length, 146; tail, 23; hindfoot, 22; ear, 13. Skull heavier, larger and broader; color, bright cinnamon (neutralized sandy orange). Guard hairs thicker and more bristlelike, giving a darker appearance to the individual than in specimens of *S. cooperi gossii.*

Color.—Type, upper part of body a bright cinnamon (Ridgway, 1886), base of hairs plumbeous. Guard hairs black, bristlelike. Flanks grade into color of underparts, the hairs of which have a plumbeous base, tips silver, with light wash of cinnamon in middle region of belly. Under fur on hip glands slightly lighter than surrounding under fur. "Mustache" prominent with numerous black bristles much shorter and heavier than the vibrissae.

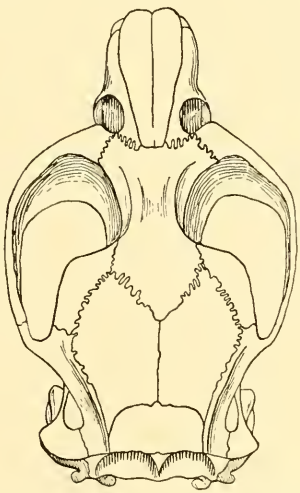

FIG. I. *Synaptomys cooperi paludis subsp. nov.* holotype, No. 13713, Kansas University Museum of Mammals. Dorsal view of skull. × 2.

Skull and dentition of type.—Skull similar to *S. c. gossii* but larger, the greater length of the skull being the region posterior to M^3. The bullae are larger. Interorbital ridges heavier, more pronounced but separated by a wider groove in the interorbital region. Temporal ridges are continuous with the interorbital ridges, being better developed along the parietal and squamosal boundary. Measurements in millimeters; condylobasal length, 28; zygomatic breadth, 18.6; incisive foramen, 5; maxillary tooth row, 7.3; width of upper incisors (normal, one groove each), 4.1; mandibular tooth row, 7; greatest width of lower jaws measured across tips of angles, estimated, 17.9 (lower jaws separated in type).

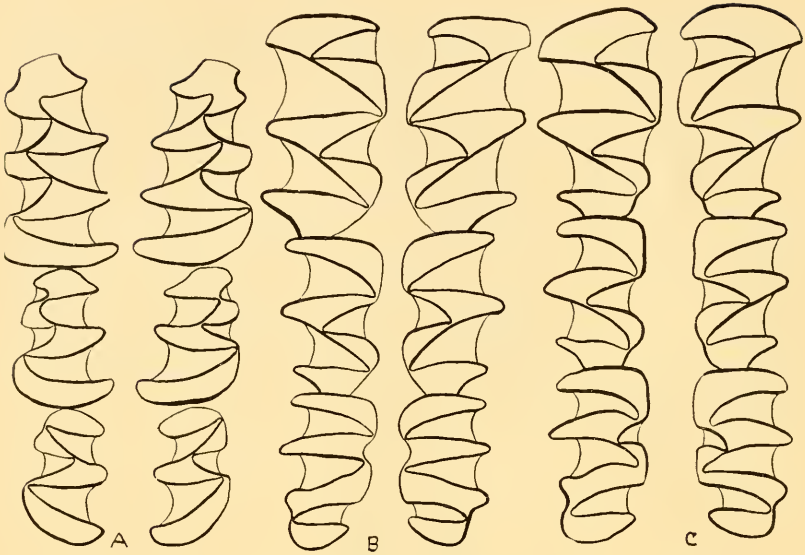

FIG. II. Teeth *of Synaptomys cooperi*. A. *Synaptomys c. paludis subsp. nov.*, holotype. Occlusal view LM_1-M_3 and RM_1-M_3. × 10. B. *Synaptomys c. paludis subsp. nov.*, holotype. Occlusal view RM^1-M^3 and LM^1-M^3. × 10. C. *Synaptomys c. gossii* (Coues), topotype, No. 5016, Kansas University Museum of Mammals. Occlusal view RM^1-M^3 and LM^1-M^3; note abnormal pattern of M^3. × 10.

Variation.—The immature specimens are plumbeous. The smallest specimen taken is a male 97 mm. in length. The adult color is beginning to appear on the muzzle and just anterior to the ear region. A male 116 mm. total length has an increase of adult coloration in the head region and the appearance of adult coloration as a small patch in the hip region. Another male 120 mm. in length has the adult coloration covering the head region, forelimbs and shoulders, hips and in the flank regions. A female 115 mm. in length possesses a greater amount of adult coloration and looks much like an old worn pelage possessing a series of shed lines. The adult pelage covers the head except between the ears where there is a patch of immature pelage, forelimb, shoulders, hind limbs, hips, flank regions, also a small patch between shoulders and across top of the hip region. Between the ears, in the middle of the back and on the rump, adult pelage shows through the immature pelage.

Of the nineteen skulls of *S. c. paludis* available for study, ten possess upper incisors with two grooves each. The added groove in most specimens is as wide and deep as the outer or normal groove. The added groove appears in both young and adult specimens and does

not seem to be an age character. In one specimen, No. 13709, an immature male, the two grooves converge on the upper incisor, meeting at the alveolus. The appearance of this character is probably due to a large amount of inbreeding that must take place in a stock living in such a small area. The individuals surely do not travel much from one area to another area, since no skull or lower jaw has been recovered from owl pellets in Meade county. Owl pellets have been collected in the area for the past six summers, and from them have been receovered remains of all of the other small mammals found in the area.

Average and extreme measurements in millimeters of the type and seven paratypes, consisting of seven adult males and one adult female; skull, condylobasal length, 28.2 (27.5-29); zygomatic breadth, 18.6 (17.9-19.7); incisive foramen, 5.17 (4.9-5.6); maxillary tooth row, 7.54 (7.3-8.0); width of upper incisors, 3.95 (3.7-4.2); mandibular tooth row, 7.15 (6.9-7.5); greatest width of lower jaws measured across tips of angles, 17.47 (16.6-18.4). Average and extremes of seven adult males and one adult female (type and seven paratypes); total length, 147.5 (142-154); tail, 21.87 (18-23); hindfoot, 21.87 (21-22); ear, 12.87 (12-14).

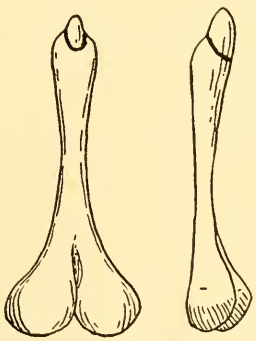

FIG. III. *Synaptomys c. paludis*. Baculum, dorsal or ventral view (probably dorsal) and lateral view. × 12.

Only one baculum was recovered, and this was freed from the dried penis in the laboratory, so it is impossible to know which is the dorsal or ventral side. On the anterior end is a second center of ossification, producing a small bone separated from the main shaft by a thin layer of cartilage in the individual recovered.

The two females possessed mammae numbering $\frac{1}{1}$, $\frac{2}{2}$.

Comparison of S. c. paludis with S. c. gossii (Coues).—The one topotype from Neosho Falls, Woodson county, an adult female in fall pelage, is a dull cinnamon (Ridgway, 1886). The other specimens from Anderson and Douglas counties were taken in fall, winter or spring. There is not a series of adults from any one season so as to be certain of the coloration of the pelage during a given period. Most of the specimens from Douglas county are isabella (Ridgway, 1886) in color. A few from Douglas county and those from Anderson county are intermediate in color between a dull cinnamon and an isabella. The Stafford county specimen, an adult female taken August 20, 1927, should correspond in color more nearly with that of the Meade county specimens, though it is distinct, being a fresh bistre (Ridgway, 1886), (deep sandy). We are indebted to Mr. Walter Yost for the analysis of the colors and for the comparison made with Ridgway's color chart.

In the Museum collection are 62 skins and skulls and 25 skeletons of *Synaptomys cooperi gossii* taken from the following counties in Kansas: Douglas, Anderson, Woodson and Stafford. These 87 specimens were collected during the following years: 1894, 1924, 1925, 1926, 1927, 1928, 1929, 1931 and 1937. Only one topotype exists in the collection, an adult female from Neosho Falls, Woodson county, No. 5016, length 135; tail, 23; hindfoot, 20; ear, 9. A single specimen, No. 5548, was taken from Little Salt Marsh, Stafford county, in 1927. The skull of this specimen has been lost. It is a female possessing adult coloration, length, 126; hindfoot, 20; tail, 15; ear, 11. From the series of 87 specimens of *S. cooperi gossii* from Kansas the eight largest specimens, 6 females and 2 males, have been selected for comparison with *S. cooperi paludis*. Their measurements are as follows: average and extremes, total length, 137.1 (134-148); tail, 19.75 (16-23); hindfoot, 20.5 (19-22); ear, 10.75 (8-14); condylobasal length, 26.7 (26.1-27.5); zygomatic breadth, 17.28 (16.6-17.9); incisive foramen, 4.97 (4.8-5.2); maxillary tooth row, 7.2 (6.8-7.4); width of upper incisors, 3.3 (3-3.5); mandibular tooth row, 6.75 (6.5-7.1); greatest posterior width of lower jaws measured across tips of angles, 15.2 (14.4-16.2).

The most conspicuous difference observed between *S. c. gossii* and *S. c. paludis* is the greater width across the angles of the lower jaws of the latter. The spread of the angle on each individual half of the lower jaw in adult specimens is twice as wide as the angle on adult specimens of the same sex of *S. c. gossii*.

Food and habits.—Only two plants were found to comprise the

food of the *Synaptomys*—these being *Equisetum* sp. and a large sedge. The *Equisetum* occurred in a rather large patch of perennial foxtail (*Setaria geniculata* (Lam.) Beaux). The *Synaptomys* had no runways in this area either underground or above ground. Over eighty percent of the *Equisetum* stalks in this area were cut, the lemming eating a small portion, leaving the stalk cut into lengths from 1½ to 2 inches long. These small piles of cuttings were abundant, ranging from six inches to three feet apart in the area, depending upon the abundance of *Equisetum*. Under each pile of cuttings were abundant feces of the *Synaptomys*. The tall sedge was cut in the same manner; though the sedge was more abundant, it was not used for food as much as the *Equisetum*. Many sedges occurred in the bog, only one was observed to have been used for food; there were also grasses and some rushes, although the latter two were never found to be used for food. No individuals were observed feeding; however, in the evening when traps were being set just at sundown, the *Synaptomys* could be heard feeding and cutting the sedge. It was possible to approach within five to six feet of an individual, but the plant growth was so dense that one could not see through it. On parting the sedge, a fresh pile of cuttings would be found with fresh feces underneath.

A. Brazier Howell, (1927) p. 8, makes the following comment in regard to the molar teeth of *Synaptomys*. "The molars, although hypsodont, never project so far beyond the alveoli as do those of most other genera of microtines with hypsodont dentition, and hence there is less provision made for rapid wear. Therefore, the teeth must be unusually resistant, or else the food is less abrasive than is that of most voles. Of these two theoretical explanations, the former is considered unlikely. The facts as known seem to justify the conclusion that the molars grow at a less rapid rate than in most other genera of the subfamily, and hence are of a less pronounced order of hypsodontism." The type of plants which were observed to have been fed upon by the lemmings, such as, *Equisetum*, which contains large amounts of silica and the sedge, which also contains considerable silica, indicate that the molar teeth are very resistant to wear, and moreover that they are kept well worn by the type of vegetation eaten and may, in fact, grow far more rapidly than the molars of other forms feeding upon food with a smaller silicious content. Oatmeal, oatmeal and raisins, and apple were used as bait in trapping; in no case were the *Synaptomys* known to have taken the bait. The traps were set in most cases where there were fresh cuttings and the

catch seems to have been accidental. The number of traps set in the areas used by the *Synaptomys* would allow for a number of chance catches without the taking of any bait.

The entire bog was combed for runways and nests. A few runways were found leading into nests of old grass, but owing to the abundance of rain they were water soaked, and it was impossible to tell whether they had been used by *Synaptomys*. During most of the period of trapping, water covered much of the bog from one-fourth to two inches in depth. The area was revisited the last of August and the signs of *Synaptomys* were as numerous as before any trapping was done in the area in July.

As stated above, over 200 *Sigmodon hispidus* were removed from the bog area and around its edges; few cotton rats were taken from the heavy sedge growth, but they overran the grass areas and especially the area where the perennial foxtail and *Equisetum* were found. Harvest mice, *Reithrodontomys megalotis* (34 specimens taken) and *Peromyscus maniculatus* were common throughout the area. *Peromyscus* was next in abundance to *Sigmodon*. Also, there were eight specimens of *Crypotis parva* taken from the area.

Discussion.—Those not familiar with Meade county, and looking only on a map for reference would wonder greatly at the presence of *Synaptomys* in the so-called "Dust Bowl." Western Meade county lies in the High Plains section while the eastern part of the county is in the Plains Border section as defined by N. M. Fenneman (1930). Crooked creek is the major stream flowing through the greater portion of the county. Chiefly along the west side of Crooked creek and along the tributary streams leading into Crooked creek are numerous artesian springs. A few of these occur on the east side of Crooked creek. They extend from above Fowler, Kan., southward to Meade County State Park. The discharge from these springs is from a few gallons up to more than 800 gallons a minute. For further reference see Frye (1940). This flow is deep seated and usually produces a quicksand area at the place of discharge. Around the discharge areas, bogs have been developed that support many plants, especially, sedges, grasses, rushes, reeds, cattails, etc. The bog areas are favorable to *Synaptomys*. Many acres of meadow land occur along the flood plain of Crooked creek which have not been drained or heavily pastured, and should furnish a suitable habitat for *Synaptomys*.

At the present time *Synaptomys c. paludis* is known only from bog areas in the State Park, but should be found in the other iso-

lated bog areas which furnish suitable food and cover. The probable range should be along Crooked creek in Meade county, marshy areas along the Cimarron river in Seward and Meade counties, also in Beaver county, Oklahoma. They should be found along portions of the Beaver river in Beaver county, Oklahoma, where we have observed favorable habitats, though we have not had time to examine them. The range of *Synaptomys* in Meade, Seward and Beaver counties must have been widespread along the stream valleys when the country was first settled, for larger meadows existed along the flood plains of the Beaver and Cimarron rivers, and along Crooked creek. Many parts of the meadows were marshy and supported a large number of muskrats. The area between the true marsh and meadow would be the ideal area for *Synaptomys*. With the arrival of the "settlers" the meadows were cut for hay and burned in areas to furnish pasture. In many cases they were drained and plowed. Along the banks of the Cimarron river were large groves of native cottonwood as well as extensive meadows. The cottonwoods were cut, not only by the people along the river, but by those living on the plains. Following the settling of the country, large areas on the upland were plowed, heavy grazing was practiced and the beavers were exterminated.

Until 1914 the Cimarron river was narrow, with grassy banks and extensive meadows on the flood plain, a permanent stream of clear, flowing water with some deep pools and abundant fishes. Much hay was cut along the river, and only two short timbers thrown across the river were needed to transport the baler. On May 1, 1914, there occurred one of the greatest floods along the Cimarron watershed that has ever been known. Due to the cutting of the cottonwoods, the extinction of the beaver, extensive plowing in the upland, and heavy grazing, the fast runoff of the water scoured the Cimarron river bed in places to a depth of thirty-five feet. As the flood cut the channel deeper, it filled it with sand released by plowing and overgrazing. During the flood, the few trees which had not been cut were washed out and covered by sand. The river channel changed from that of a narrow stream with a few feet of clear water to a broad sand bed with many sand bars which allows the constant blow of sand along the channel carrying a shallow stream, whose water is silty most of the time. The down cutting of the river channel and filling with gravel and sand had the same effect as that of laying a large, deep-seated drainage tile through the area. The flood plain drained at once into the channel. Most of the river flow being under-

ground, the meadows dried out and the grasses died, being replaced by sagebrush, sand plums, buffalo gourds, and small sand dunes. Following along the banks of the Cimarron one may see exposed areas of dark soil full of plant remains marking the once common water table that supported the larger meadows and marshes. This change in the water table and flora along the Cimarron in recent times must have had a great effect upon the fauna. *Synaptomys,* which could once have been common along the valley, must now exist only in isolated areas. This same change has taken place along Crooked creek and the Beaver river, in part, but not as greatly as along the Cimarron.

Conditions seem to have been favorable for the occurrence of *Synaptomys* in Meade county and adjoining areas throughout the Pleistocene, both during certain phases of the glacial and interglacial stages and the Recent. Artesian springs which must have existed in the area since middle Pleistocene would help to maintain a natural habitat for this bog-lemming; also, the occurrence of sink holes has helped to provide isolated habitats. Sink holes began to appear in Meade and Beaver counties at the close of the Tertiary and have been present throughout the Pleistocene and into Recent times. These sink holes, when they have ceased to be active and have become plugged, form lakes in their basins around the border of which appear marshes and meadows. The life of these lakes is long and lasts either until the sink hole is filled, until they are dissected by head erosion of a stream or until the sink again breaks through and allows further drainage.

The oldest geological record of *Synaptomys* in Kansas is that of the subgenus *Mictomys*, specimens of which have been taken from the Pleistocene of Meade county below the horizon of the Borchers fauna. There is some evidence that these were associated with the boreal fauna that inhabited the area just prior to the Borchers fauna. *Synaptomys* (*Mictomys*) cf. *vetus* Wilson was reported by Hibbard (1941) from the Borchers fauna. This form was incorrectly referred by Hibbard to the subgenus *Mictomys.* It must be considered as belonging to the subgenus *Synaptomys.* Outer external triangles are not present or indicated in the M_1 and M_2 of the subgenus *Mictomys,* while the M_1 and M_2 of the *Synaptomys* from the Borchers fauna possess an open external triangle, a condition which can be observed to a lesser degree in some immature specimens of *S. cooperi. Synaptomys vetus* Wilson (1933) cannot be considered as intermediate between the two recent subgenera since it possesses the

open external triangles. *Synaptomys bunkeri* Hibbard (1940) is known from a later Pleistocene horizon than that from which the Borchers fauna was taken. It was taken from a dissected sink in Beaver county, Oklahoma, along the north side of the Cimarron river on the XI ranch. It is distinguished from *S. c. paludis* by its larger size, and the pattern of M_1.

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Tadpoles of Mexican Anura

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ABSTRACT: Tadpoles of the following species are described and figured: *Scaphiopus multiplicatus* Cope, *Agalychnis dacnicolor* (Cope), *Rana pustulosa* Boulenger, *Rana montezumae* Baird, *Hypopachus caprimimus* Taylor, *Hypopachus alboventer* Taylor. *Plectrohyla matudai* Hartweg is discussed. A remarkable tadpole is described and figured without placing it in a species or genus. The eggs of *Agalychnis callidryas* are described.

THE EHT-HMS collection contains numerous series of Mexican tadpoles which have been accumulating during the past ten years. Some thirty species have been identified, with reasonable certainty; and drawings are being prepared, as occasion permits, so that certain details of this stage of their life history can be made known to others. Certain other species have been tentatively identified on the basis of probability, taking into consideration the fauna in the locality where they were found and the adult species taken in their particular breeding pool at various times. Frequently tadpoles can be referred to a given genus or family on the basis of generic similarity. However, this is not always possible. I am ignorant of even the family relationship of the species which I here describe, and figure.

GENUS? sp?

(Plate I, figs. 2, 2a, 2b)

The tadpoles of this species have been obtained two different years from a temporary pool near La Venta, Guerrero. The species is gregarious, the larvae moving usually in a ball-like mass, coming to the surface and submerging as if the mass was revolving. They keep to the deeper water (3 feet). None was taken near the edge of the water where most tadpoles are accustomed to feed.

The dates of collection of this form are, No. 27692A, July 30, 1937, and No. 27692, July 4, 1938. Specimens from both lots are in about the same stage of development.

Description of tadpole (from EHT-HMS No. 27692 consisting of about 130 specimens).—Head and body somewhat longer than broad; the snout flattened, truncate; the lips thin, the lower lip bending in and covered by upper; no horny beak; no series of labial teeth present; no papillae surrounding edges of lips; a single, sharply pointed dermal spine directed forward from near the edge of the lower lip; width of mouth opening about equal to half width of head; palate and floor of mouth with only a few tiny papillae, scarcely discernible; two shallow pockets in front of gills; nostrils dorsal, nearer the level of the eyes than edge of mouth, narrowly separated, the distance between them equal to about half their distance from eye; eyes small, lateral; skin largely transparent so that in lateral and ventral view the coiled intestine, the gills, and the heart are visible; the pericardium is pigmented; on underside of head there is visible a heavily pigmented transverse band of muscle that lies about as far forward as the level of the eyes; spiracula bilaterally symmetrical, sinistral and dextral, opening lateroventrally; the distance between eye and spiracle nearly twice distance of eye to mouth. Caudal fin transparent, arising near middle of back, low anteriorly, attaining its greatest height above and below at the middle, tapering to a fine point at tip; terminal portion of intestine included in the ventral part of caudal fin, the anal opening being medial at the edge of the fin; limbs small, flattened. Other details of the anatomy are indicated in the figures.

Measurements in mm.—Total length, 41; length of head and body, 17; width of body, 11.3; distance between eyes, 9.3; distance between nostrils, 2; length of tail, 31.

Color.—The body wall is transparent, and the coloration is largely that of the internal organs, which are greenish-olive in life. The tail musculature has some scattered pigment, the fin clear, transparent, without color.

Remarks.—In the presence of a spiracle on each side of the body and in the presence of a dermal spine, this tadpole differs from the other tadpole species in the collection.

Mrs. Helen T. Gaige in her paper "Some Reptiles and Amphibians from Yucatan and Campeche, Mexico," mentions a tadpole from Piste, Yucatán, which is thin-lipped, and lacking a horny beak and teeth. She suggests that the species may be *Tetraprion petasatus*.

That species is as yet unknown in Guerrero. However, *Diaglena reticulata,* a recently described species of a genus believed to be related to *Tetraprion,* may occur, since it comes from the Tehuantepec region in Oaxaca. Double spiracla occur in certain PIPIDAE.

Plectrohyla matudai Hartweg

A recent paper by Hartweg and Orton, 1941, describes two tadpoles from Mt. Ovando, Chiapas, believed to be those of species of the genus *Plectrohyla,* either *Plectrohyla sagorum* Hartweg or *Plectrohyla matudai* Hartweg. The authors were unable "to correlate each of the larval forms with the adults of the correct species."

The tadpoles (both species) were said to have been taken at an elevation of approximately 1,800 meters from a stream on Mt. Ovando at the same elevation where adults of the two species were collected in August, 1937.

Dr. and Mrs. Hobart M. Smith, who visited Mt. Ovando April 15-18, 1940, rediscovered the two species, and collected a series of adult specimens as well as a series of tadpoles and transforming young. These latter have been sent to me by Doctor Smith, calling my attention to the fact that the tadpoles will identify Hartweg and Orton's figures 1 and 2.

Smith did not find the two species of *Plectrohyla* in the same habitat. He recognized the two species in the field, noting differences in their calls and in habitat. One form, designated as the "sharp-nosed species" (= *Plectrohyla sagorum* Hartweg), was found in bromelias at 5,000 feet and higher, that representing the approximate elevation at which bromelias begin to appear on the mountain. Apparently none was found in any other habitat. The other species which he mentions, as the "rough-skinned form" or the "ravine form" (= *Plectrohyla matudai* Hartweg), was found in small streams from about 2,800 feet up to about 6,000 feet elevation. The call of this form is noted as sounding "like a couple of rocks struck once under the water, just a single note"; while in the bromeliad form, the call is a "croak—that sounds somewhat like the spoken word drawn out a little."*

Smith obtained with his *P. matudai* a series of transforming young together with tadpoles at Las Nubes (approximately 2,900-3,000

* In the description of *Plectrohyla matudai,* Hartweg states, "no external vocal sac in the male"; of *Plectrohyla sagorum* he states "males with a vocal sac"; he later states, "*P. matudai* differs from *P. sagorum* in the absence of vocal sacs in the males, . . . I found that the vocal sacs are equally developed in both species taken by Smith, and suspected that they might have been overlooked by Mr. Hartweg in his *P. matudai.* I communicated with him and he writes as follows: "*P. sagorum* has well-developed vocal sacs but *P. matudai* has no external evidence of vocal sacs, although 'vocal sac openings' are present."

feet). These include tadpoles in which the hind legs are just beginning to form, up to individuals that have lost the labial beak and teeth, with well-developed limbs, and only a remnant of the tail. These tadpoles agree in most details with the form which Hartweg and Orton designate as *Plectrohyla* "Form *a*." It has the same typical fanglike serrations on the upper beak with the smaller secondary serrations as is shown in figure 2. The serrations on the lower jaw are, for the most part, small and uniform, but the posterior serration is enlarged. It seems reasonably certain that *Plectrohyla* "Form *a*" is the larval form of *Plectrohyla*† *matudai*.

Hartweg‡ obtained the two forms of tadpoles in an area and at an elevation where Smith found the ranges of the two adult species overlapping. The finding of tadpoles transforming in the middle of April in the dry season, and again in the latter part of August, during the rainy season, shows that the breeding season of *Plectrohyla matudai* occurs more than once during the year, or continues for several months.

Agalychnis dacnicolor (Cope)

(Plate II, figs. 2, 2a, 2b; Plate III, fig. 2)

The eggs of this species are usually deposited on the leaves of plants (preferably large, smooth leaves) near the edge of water pools or on branches overhanging the water. I have on occasion found eggs placed on the earth a few inches above the water in pools where no trees or plants were available.

The eggs, green in color, are encased in thick gelatinous capsules which adhere to each other and to the plants or other substrata where they are deposited. When the young hatch they are washed by rain or fall into the water, and develop as ordinary tadpoles.

The egg-laying season apparently continues for some weeks, since in several collections of these tadpoles, newly hatched young and large tadpoles with the hind limbs beginning to appear, were found in the same pool.

Description of tadpole (from a lot collected at Km. 363 near Ocotito, Guerrero).—Body and head nearly twice as long as wide, the head not wider than the body; eyes very large, laterally placed, the distance between them nearly equal to width of head, and much

† The use of the name *Plectrohyla* for the genus of Hylid frogs having a spine on the pollex is open to question. I strongly suspect that *Plectrohyla* is a synonym of *Hypsiboas* Wagler. The genotype of *Hypsiboas* is *Hyla langsdorffii* Duméril and Bibron. I have no specimen of that species at hand to judge whether the two are congeneric.

‡ The date of collection is not specifically mentioned by Hartweg and Orton, but it is inferred that these tadpoles were taken on about the same date as the adults (August 28-30, 1941).

greater than their distance to middle point of snout tip; distance between nostrils greater than their distance to mouth, much nearer tip of snout than eye; tail musculature begins near middle of body; tail narrowing gradually to a pointed tip; the caudal segments not distinct throughout; dorsal part of the caudal fin which begins somewhat back of the beginning of the musculature is low at first then rises to its greatest height for the middle third of the tail, then narrows gradually on the posterior third; ventral part of caudal fin begins its greatest elevation at base of tail and maintains it for nearly two-thirds of length of tail, where it tapers gradually to a narrow tip.

Anus dextral; spiracle sinistral, not forming a tube, opening ventrally, its distance from eye nearly same as distance between eye and tip of snout; width of mouth a little more than one-third width of head, the lips short, rather thin, bordered by a single (usually) row of papillae, save for the medial part of the upper lip, which is smooth.

Horny beak well-developed, the edges of upper and lower parts of beak bordered by fine denticulations; upper lip with a continuous transverse series of labial teeth, followed by a shorter series on each side of the upper part of beak; lower lip with three series of labial teeth, the outer a little shorter than other two, the inner broken medially; on the lips on each side of the beak, are groups or series of papillae.

Color.—Above flesh color with bright-blue markings; paired symmetrical dark marks on top of head and dark spots above eyes and behind nostrils; a darker area at beginning of dorsal musculature often touching the dark spots on head; tail musculature with some pigmentation, fin with very sparse pigment.

Measurements in mm.—Head and body, 22.5; total length, 52.6; greatest depth of tail including fins, 11.2; distance between eyes, 9; snout to base of tail, 10.

Remarks.—The tadpoles of this species may readily be recognized even when quite young by the bluish coloration which is not known in other genera of Mexican frogs (but may be present in other *Agalychnis*). The bluish color fades rapidly and no trace of it is evident in my preserved material.

No newly transformed young have been found during the summer months, so I presume that they transform in September or October. One collection made by Dr. Hobart M. Smith, October 30, 1936, at a point 30 Km. south of Chilpancingo contains five tadpoles. The tails are beginning to shorten; the legs are from 25 to 32 mm. long; the arms are still concealed. The horny beak and labial teeth have

been lost in all but one specimen. The color in life is green above with numerous clear cream spots, while below the color is creamy yellow.

Agalychnis callidryas

Freshly laid eggs of *Agalychnis callidryas*, a much smaller species, were obtained near Tierra Colorada, Veracruz, July 16, 1932. The greenish eggs of this species were deposited in the same manner as those of *A. dacnicolor*. However, the individual eggs are a little smaller and the masses scarcely a third as large. Dr. Hobart M. Smith collected an egg mass of this species at San Andres Tuxla, Veracruz, September 9, 1935. In the mass there are 95 eggs, which were taken with the curled-up leaf on which they were laid. The label states "egg mass entire."

Scaphiopus multiplicatus Cope

(Plate II, figs. 3, 3a, 3b; Plate III, fig. 3)

The type locality of this species, "Valley of Mexico," state of México, México, is to be sure somewhat indefinite as the extent of the *valle* is variously understood. However, I believe that the tadpoles obtained at El Guardia in the mountains near the continental divide, southwest of Mexico City may be regarded as topotypic. The series EHT-HMS No. 27692 consists of some 75 specimens, perfectly preserved except for life colors. The shallow pool where they were collected was formed in an excavation where the earth had been removed for road building. The elevation is approximately 10,000 feet. Some adult specimens and one partly transformed young were found under rocks in the immediate neighborhood. Most of the specimens have the hind legs more or less developed.

Description of tadpole (from EHT-HMS No. 27692, El Guardia, Mexico).—Head and body large, the head somewhat angular in profile; the snout more or less truncate; eyes small, dorsally placed, the distance between eyes equal to their distance from tip of snout, or about one-third the greatest width of head; nostrils small, situated rather close together, the distance between them about equal to their distance from eyes. Tail with moderate musculature, longer than head and body, the fin well developed above and below, upper part of fin arising at base of tail, low anteriorly, reaching its greatest height at about the middle; muscular portion not wider than fin, tapering to a point posteriorly; spiracle sinistral, forming a slight tube, opening lateroventrally; distance between spiracle and eye greater than distance between eye and tip of snout; anus medial,

opening in the lower edge of the caudal fin, which has a tendency to form a slight fold either to right or left.

The width of mouth is as great as or a little less than the distance between eyes; the lips are a little thickened, protruding slightly, the edges bordered by two continuous rows of papillae save for a short diastema in the middle of upper lip; at this point there is a smooth flap or area bordered by a short row of labial teeth; horny beak strongly developed, the upper and lower parts bordering jaws have their edges finely serrated (the serrations smaller and much more numerous than indicated in the figures).

Upper labial teeth with the very short median series mentioned, followed on each side of the upper part of beak by three series of teeth, the outer somewhat sinuous, more than double length of second, almost meeting in the middle, third row very short, the teeth smaller than in preceding rows; lower edge of lower lip with a median series, then follow three series on each side, the first minutely separated in the middle, the second and third shorter, widely separated, the third less than half length of second; a few additional papillae at corner of mouth fold.

When mouth is opened widely a median palatal tubercle is observable; a small circular moundlike tongue is visible behind lower jaw surmounted by two irregularly shaped papillate structures; bordering the inner part of jaw are three irregular papillae, two pointing somewhat medial, the other downward. On palate and on lower floor of mouth numerous small papillae, more or less regularly placed; in front of the gills an elevated continuous muscular flap present. These latter characters are only visible when the sides of head are cut open.

On many of the specimens the skin of the posterior dorsal part of the abdomen tends to wrinkle or pucker somewhat, across base of tail.

Color.—Olive to olive-gray on head with a somewhat darker median area between eyes and about nostril (not pronounced in specimen figured); an indefinite lighter line back of head crossing body (variable in its distinctness). Abdominal region blackish above and below, the intestine rarely visible save in youngest tadpoles; musculature of the tail grayish-brown with the segments definitely marked in younger, indefinitely indicated in oldest specimens; the fin is completely transparent, what appears to be pigment is clotted blood in the blood vessels. Underside of legs usually unpigmented, dorsal surface with indistinct transverse bands.

Measurements in mm. of figured specimen.—Total length, 34.2;

head and body, 15.2; tail from posterior part of abdomen, 19; greatest depth of body, 8.2; width between eyes, 3.3; width of mouth, 2.7. Another specimen with the legs about half the size of the figured specimen has these measurements: total length, 51; head and body, 21; tail from posterior part of abdomen, 30; greatest depth of body, 11; between eyes, 3.8; width of mouth, 3.

Remarks.—The specimen chosen for illustration has the tail a bit shorter than younger tadpoles, since the process of resorption seems to have begun. In many of the specimens tooth rows become strongly sinuous. Some of the specimens are a little less angular about the head.

A young specimen nearly transformed, with the arms as well as legs distinct, the tail reduced to a stub less than length of body, has a snout-to-vent length of 20 mm.

A few other specimens, having the legs at the same stage of development as the larger, measured tadpole, are variably smaller.

Arthur N. Bragg* has recently studied larvae of *Scaphiopus, bombifrons* and *S. hammondi* and finds that there is marked difference between them. He points out the fact that certain previous authors have confused the tadpoles and shows that the form with a hooked beak and notched lower mandible is actually *hammondi.*

If Bragg is correct, then *multiplicatus,* the form herein described, differs so greatly from *Scaphiopus hammondi* in the larval characters, that it does not seem probable that a subspecific relationship exists between them. In consequence I shall regard them as distinct species.

Rana pustulosa Boulenger

(Plate I, figs. 1, 1a, 1b; Plate III, fig. 4)

This species is represented in the collection by two lots as follows: EHT-HMS No. 27690, a series of ten tadpoles from young to transforming stages, taken at Km. 142, to the north of Taxco in Morelos, July 16, 1936; and No. 27689, a series of 26 tadpoles with one transformed young, taken at Km. 133 near Huajintlán, Morelos, June 27, 1938. Adults of *R. pustulosa* were taken at the latter locality at the time the tadpoles were taken.

Description of tadpole (from lot No. 27689).—Head and body somewhat flattened, much longer than wide; eyes large, dorsolateral, the distance between them less than length of snout; nostrils small, widely separated, the distance between them almost as great as that

* Bragg, Tadpoles of *Scaphiopus bombifrons* and *Scaphiopus hammondi.* The Wasmann Collector, Vol. 4, No. 3, Apr., 1941, pp. 92-94.

between eyes, situated equidistant between eye and median tip of snout; spiracle forming a slight "tube," sinistral, laterally placed; anus dextral; musculature of the ventral body wall showing more or less distinct septa; musculature of tail beginning near middle of body, much wider than the fin anteriorly, tapering to a point posteriorly; fin narrow above and below at base of tail, widest near the beginning of posterior third.

Mouth moderately large, with a strong horny beak; both upper and lower parts thick, with the edges strongly denticulated; upper lip bearing teeth on its edge, lacking papillae for most of its width, its corners, however, with rather free papillate edges; lower lip bordered by a single or partially double row of papillae; upper labial teeth arranged as follows: a transverse arched series anterior to beak; four series on each side of beak diminishing in width posteriorly; lower lip with two outer (usually) unbroken transverse series followed by a third which is interrupted medially; near corners of mouth two short somewhat isolated series on each side.

Color.—Head and body more or less uniform dark olive-brown above and on sides; ventrally lighter with a median darker stripe and narrow transverse lines which seem to mark septa in the musculature of the body wall; tail musculature with a slight scattering of pigment; tail fin transparent save for distinct scattered spots of brown, which likewise occur on the tail musculature.

Measurements in mm. of figured specimen.—Total length, 65; head and body, 24; tail from anus, 40; head width, 12.5; depth of body, 11; depth of tail with fin, 11.5; distance between eyes, 5; distance between nostrils, 4.2.

Remarks.—When the palate and floor of the mouth are exposed by cutting back from mouth along the side of head, the following characters are discernible: On anterior part of palate a group of papillae or tubercles roughly arranged in an H-shape; the large transverse choanae with minutely tuberculate edges; a very large spinose or tuberculate papilla arising from the outer anterior edge, and a smaller one from the inner posterior edge; closely following the choanae are three spinose papillae directed somewhat mediad; following this is a thin elevated ridge with a denticulate edge and spinose on anterior and posterior surfaces; behind this the palate covered with numerous tiny spinose papules or papillae varying greatly in size; on the posterior part of the palate on either side are two angular pigmented areas; within the lower part of beak on lower jaw is a small tongue anlage bearing two elongate spinose papillae

which are contiguous; at the back edges of the jaw on each side is a flattened papillae; the floor of the mouth papillate; a free cartilaginous flap in front of the gills edged with papillae or projections of various shapes arranged symmetrically.

The largest tadpole of the series has a total length of 72 mm.; the snout to anus length being 24.2 mm.; in this specimen the hind legs measure 26 mm.; a completely transformed specimen measures 28 mm., snout to vent.

The second lot of specimens EHT-HMS No. 27690 (10 specimens) contains young tadpoles as well as individuals nearly completely transformed.

Rana montezumae Baird

(Plate III, figs. 1, 5)

Two lots of material certainly identified as *Rana montezumae* have been collected. These are EHT-HMS Nos. 27717 (lot of 35, containing young tadpoles, some beginning transformation, and others in which the process is complete), San Diego, near Texcoco, D. F., August 23, 1939; 27718 (lot of 9 young and half grown), Km. 74 west of Toluca, September 11, 1939.

Description of tadpole (from lot No. 27717).—A large, robust form, the head much narrower than body; eyes dorsolateral, not visible from below, the distance between them very slightly greater than their distance to the tip of snout; nostrils nearly equidistant between the eye and tip of snout, close together, the distance between them less than their distance to either eye or tip of snout; spiracle lateral, sinistral, its distance from eye a little greater than distance between eyes; anal opening dextral. Tail musculature with well-defined segments, begins on middle of back; dorsal fin begins midway on back, rather low at first, then rising to its greatest height at beginning of middle third of tail; dorsal fin at widest part narrower than tail musculature, but wider than the ventral part; legs at this stage of development longer than head and body.

Sides of mouth and lower lip with a loose fringe of varying width bordered by a single row of papillae; a few additional papillae near corners of mouth; upper lip somewhat thick-edged bordered by a continuous row of labial teeth; behind this is a short row of teeth on each side but somewhat in front of beak; three unbroken toothrows on lower lip, the outermost shortest, all in front of beak.

Color.—Above greenish-olive, the color continued on the sides of head; abdominal region black on sides; chin, greenish or yellowish flesh; intestine visible through the abdominal wall; tail muscles, and

fins rather greenish-yellow at base becoming black posteriorly, with a few indistinct lighter dots.

Measurements in mm. (of figured specimen).—Total length, 112; head and body, 40; tail from base of limbs, 62.5; length of dorsal fin, 90; greatest height of tail and fins, 36; width between eyes, 11; eye to spiracle, 12; height of the dorsal part of caudal fin, 8.5.

Remarks.—In younger specimens the tail is dark olive, but lacks the black color of some of the older tadpoles. At the time when the arms appear the tail may still be as long as the head and body. Two transformed young, tail completely absorbed, measure 33 and 34 mm., respectively, from snout to vent.

Hypopachus caprimimus Taylor

(Plate II, figs. 1, 1a, 1b; Plate III, fig. 7)

I have collected the following lots of tadpoles of this species: EHT-HMS Nos. 27699 (lot of 7), July 23, 1936, 9 Km. south of Mazatlán (Km. 337-338), Guerrero; 27700 (lot of 3), July 27, 1936, Km. 363, near El Ocotito, Guerrero; 27707 (lot of 7), July 27, 1936, Agua del Obispo, Guerrero (Km. 350½).

The tadpoles of the genus *Hypopachus* lack a horny beak and labial teeth. The upper lip forms a pair of connected flaps that cover the lower lip. The cartilage of the upper jaw is wanting and there are no external nostrils until transformation. The spiracle opens near the anus and is usually slightly dextral.

Description of tadpole (from EHT-HMS No. 27701, near El Ocotito, Guerrero, July 27, 1936).—Tadpole banjo-shaped; head and body together a little longer than wide; eyes large, lateral, widely separated, the distance between them greater than their distance from tip of snout; no external nostrils; head somewhat wedge-shaped; tail musculature not or barely showing the septa, tapering to a point; dorsal fin begins only slightly in advance of lower, is narrow at first, then rises to its greatest elevation near the middle; the musculature of the tail wider than either fin. Spiracle opens near anus, the two openings being very closely associated if not actually continuous sometimes; leg anlage indicated as a bud.

Mouth about half width of the head, upper lip forming a pair of somewhat fleshy flaps which bend down and under snout, their bases separated medially by a small rounded space through which may be seen the narrow, somewhat V-shaped lower jaw, which has a raised somewhat irregular edge; the flaps are bordered by minute papillae. No horny beak or labial teeth.

Color.—Above closely reticulated with dark brown, appearing nearly uniformly colored; two tiny blackish dots on snout; venter blackish-brown anteriorly, the posterior part lighter with numerous cream spots or reticulations; tail brown with an irregularly edged cream stripe arising at its base, and extending nearly half its length; tail fin more or less pigmented, the pigment forming irregular brown spots.

Measurements in mm. (of specimen figured).—Total length, 21; head and body, 9; width of head at eyes, 5.6; width of body, 5.6; tail, 12.4; greatest width of tail and fin, 4; width of mouth, 1.9; leg, 1.

Remarks.—Although there are no external nostrils, usually two darker flecks are visible where the nostrils will appear later at transformation.

That these tadpoles actually belong to *Hypopachus caprimimus* has not been established beyond doubt. So far as I know no other species of the MICROHYLIDAE occurs in southern Guerrero save *Microhyla usta* (Cope). No specimens of that form were taken about these pools, while adults of *Hypopachus caprimimus* were found in each case.

Stuart (Proc. Biol. Soc. Washington, Vol. 54, pp. 125-128, Sept. 30, 1941) describes *Hypopachus simus,* also a truncate-snouted species whose tadpole, judging by the description, has mouth parts similar to the species here described. His tadpole specimens were unquestionably *simus.*

Until the tadpoles of *Microhyla usta* are known some doubt must remain regarding the tadpoles here described as *Hypopachus caprimimus.*

Hypopachus alboventer Taylor

(Plate I, figs. 3, 3a, 3b; Plate III, fig. 6)

Tadpoles of *Hypopachus alboventer* were found in temporary pools at Km. 133 near Huajintlán, Morelos. They were taken with the tadpoles of *Hyla smithi, Agalychnis dacnicolor,* and *Rana pipiens* var. In nearby pools and rivulets tadpoles of *Hyla arenicolor* and *Rana pustulosa* were collected. The date of collection for the species is, EHT-HMS No. 27701, July 16, 1936, lot of three tadpoles.

Description of tadpole.—General form banjo-shaped, the body a little wider than head; head-body length greater than its width; snout somewhat rounded in lateral profile, not wedge-shaped; eyes lateral, widely separated, the distance between them much greater than the distance to the middle of snout tip; nostril absent; spiracle opening near anus, slightly dextral, the opening apparently continu-

ous with that of anus; upper lip cartilage absent; edge of lip forming a double flap, smooth, lacking fringe of papillae; lower jaw very narrow, slightly V-shaped; no horny beak or labial teeth.

Dorsal part of caudal fin begins in advance of the lower part, relatively narrow, and about same height above and below, much narrower than the tail musculature; segmentation of tail musculature scarcely distinguishable; legs in figured specimen small.

Color.—Above brown to chocolate brown, nearly uniform, slightly lighter on sides; venter brownish with numerous irregular light cream spots; tail and dorsal fin spotted and marbled with brown; a lateral cream stripe with irregular edges arises at base and continues nearly half length of tail.

Measurements in mm. (of figured specimen).—Total length, 28; head and body, 11.5; width of head at eyes, 6; greatest width of body, 8; tail, 17; depth of tail and fin, 4.8; width of mouth, 3.3; leg, 3.9.

Remarks.—Tadpoles of *Hypopachus alboventer* resemble externally the tadpoles of *H. caprimimus*. However, the very different character of the upper lip will serve to distinguish the two forms (see figures), if the latter species is correctly identified.

Owing to the rather striking similarity in body form of the various species of *Hypopachus* one would normally expect to have relatively minor differences in the larvae.

PLATE I

FIGS. 1, 1a, 1b, *Rana pustulosa*. Actual length, 65 mm.
FIGS. 2, 2a, 2b, Genus sp.? Actual length, 41 mm.
FIGS. 3, 3a, 3b, *Hypopachus alboventer*. Actual length, 28 mm.

PLATE I

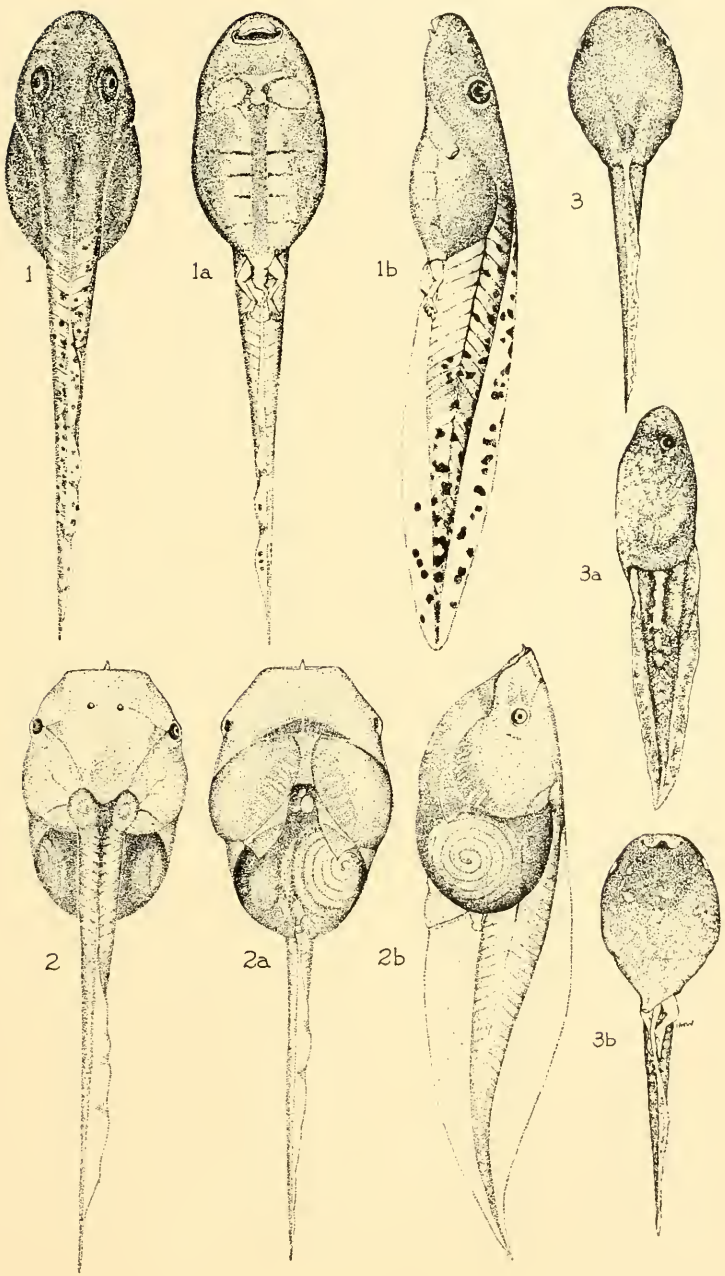


PLATE II

FIGS. 1, 1a, 1b, *Hypopachus caprimimus?* Actual length, 21 mm.
FIGS. 2, 2a, 2b, *Agalychnis dacnicolor.* Actual length, 52.6 mm.
FIGS. 3, 3a, 3b, *Scaphiopus multiplicatus.* Actual length, 34.2 mm.

PLATE II

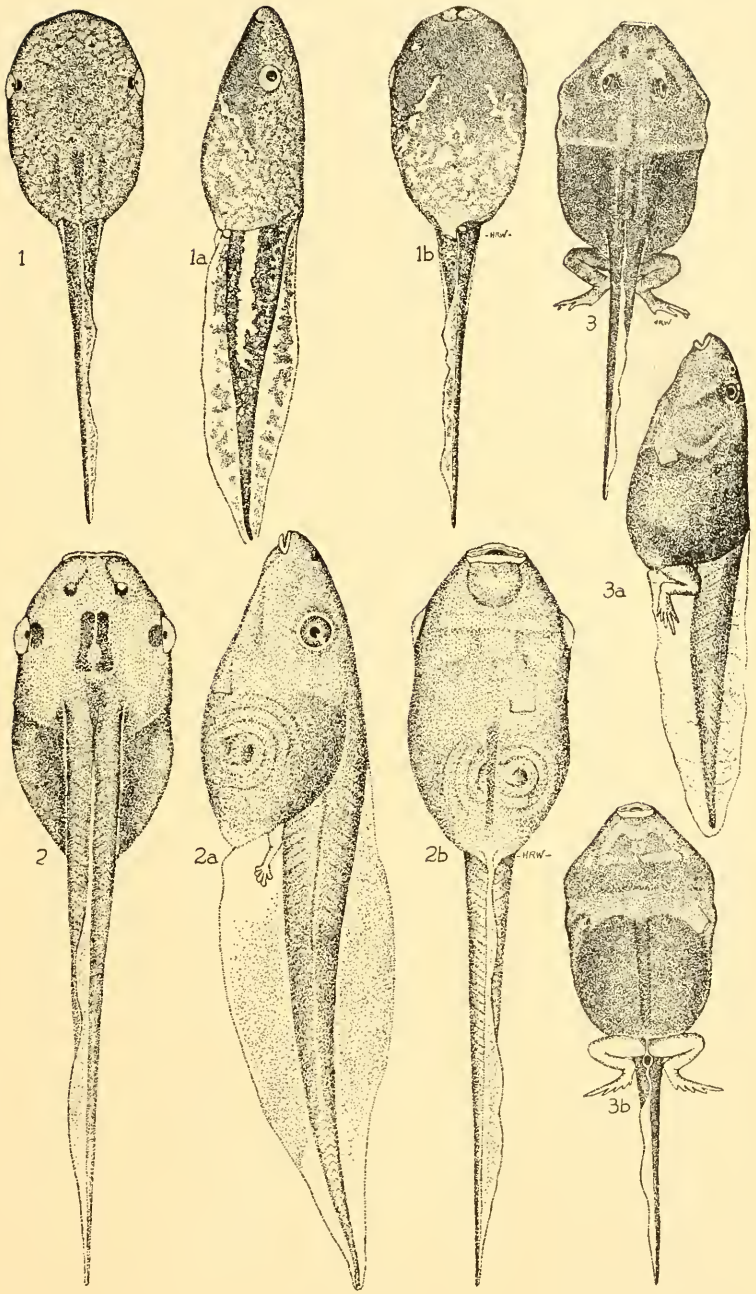
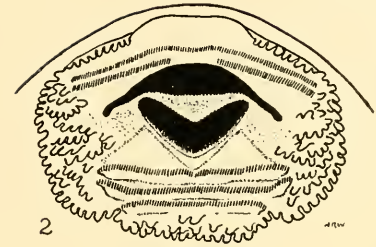
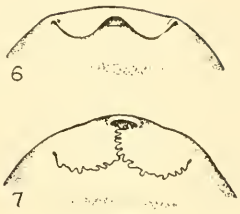


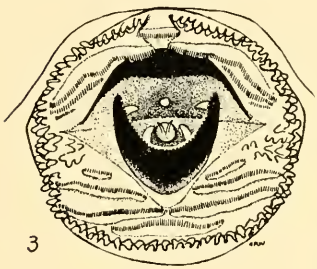
PLATE III

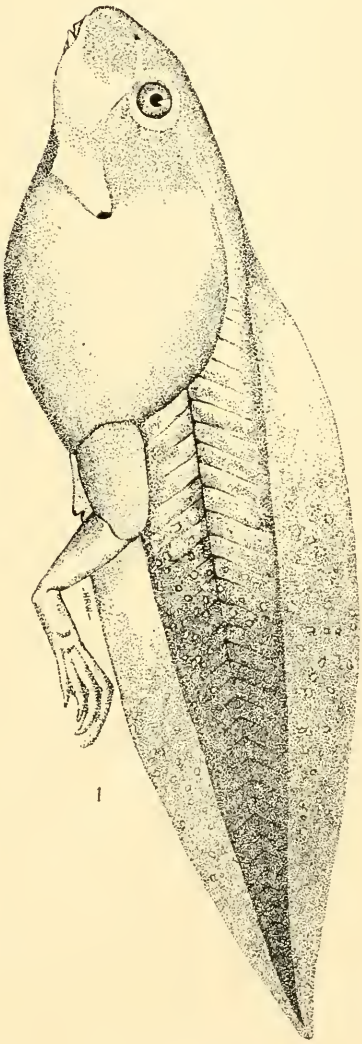
FIG. 1. *Rana montezumae*. Actual length, 112 mm.
FIG. 2. *Agalychnis dacnicolor*. Mouth enlarged.
FIG. 3. *Scaphiopus multiplicatus*. Mouth enlarged.
FIG. 4. *Rana pustulosa*. Mouth enlarged.
FIG. 5. *Rana montezumae*. Mouth enlarged.
FIG. 6. *Hypopachus alboventer*. Mouth enlarged.
FIG. 7. *Hypopachus caprimimus*. Mouth enlarged.

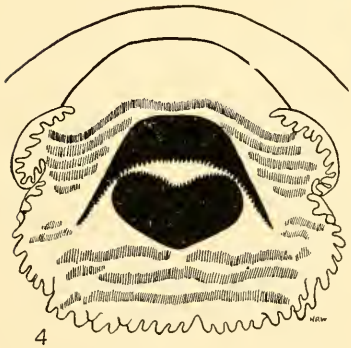
PLATE III











THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXVIII] MAY 15, 1942 [No. 4

The Frog Genus *Diaglena*, with a Description of a New Species

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ABSTRACT: A new species of frog, *Diaglena reticulata* is described, the type locality being Cerro Arenal, Oaxaca, Mexico. *Diaglena spatulata* (Günther) from Sinaloa is redescribed, and figures of both species are given.

THE genus *Diaglena* was proposed by Cope in 1887 for *Triprion spatulata* Günther (described in 1882), and until this time it has remained a monotypic genus. To date only six specimens of the species have been reported, all of them taken at the type locality except one, and that at no great distance from the type locality. Whether the actual range of *T. spatulata* is as restricted as collections show, is not known, but it is presumed that it is greater.

In 1940, Mr. Thomas MacDougall discovered a bromelicolus frog on the Cerro Arenal, Oaxaca, Mexico, a locality some 1,100 kilometers southeast of the present known range of *D. spatulata*, which proves to be a second species of this extraordinary genus, and is described in this paper. A redescription and figures of *Diaglena spatulata* are included, as a basis for comparison with the new form.

GENUS DIAGLENA Cope

Triprion Günther, Ann. Mag. Nat. Hist. (5), X, 1882, p. 279, and Biol. Centrali-Americana, Rept. and Batr., 1901, p. 293. (*part.*).

Diaglena Cope, Bull. U. S. Nat. Mus., No. 32, 1887, p. 12 (Genotype *Triprion spatulata* Günther); Boulenger, Ann. Mag. Nat. Hist., (6), VIII, No. 48, 1891, p. 456; Nieden, Das Tierreich, Lief. 46, 1923, p. 328 (including *Tetraprion* Stejneger and Test); Kellogg, Bull. U. S. Nat. Mus., No. 160, 1932, pp. 131, 132, 137.

Description of the genus.—*Hyla*-like in general habitus save head, which is developed into a bony casque with spatulate, crenellated edge; pupil horizontal; palatine teeth posterior to choanae; vomerine

teeth present between choanae; parasphenoid teeth present, small, arranged in a median longitudinal series; tongue not or but slightly notched behind. Head with a bony casque; tympanum distinct; the canthus rostralis forming a slightly elevated ridge, the two uniting near the nostrils; anterior margin of snout shelflike, continuing back to below anterior margin of eye; snout projecting far beyond lower jaw. Limbs elongate; fingers free with widened adhesive disks; toes about one-half webbed, with slightly smaller adhesive disks; a low inner metatarsal tubercle; no outer tubercle; a tarsal fold; male with a median, subgular vocal sac; no pectoral fold; diapophyses of sacral vertebra strongly widened; outer metatarsals united; omosternum and sternum cartilaginous.

Diaglena spatulata (Günther)

(Plate IV, figs. 1, 1a, 1b, 1c; Plate V, fig. 2)

1882. *Triprion spatulatus* Günther, Ann. Mag. Nat. Hist., (5), X, No. 58, Oct. 1882, p. 279; (type description; type locality, Presidio de Mazatlan); Boulenger, Ann. Mag. Nat. Hist., (6), VIII, No. 48, Dec., 1891, p. 456; Günther, Biologia Centrali-Americana, Rept. Batr., Dec., 1901, p. 293, pl. 74, fig. c (entire dorsal view, and lateral and ventral views of head. The figure is very misleading as regards the size of the digital disks, which are shown much too small and quite different from their actual shape). (Brief description of type, Presidio. Sinaloa, Mexico; Forrer, collector.)

1887. *Diaglena spatulata* Cope, Bull. U. S. Nat. Mus., No. 32, 1887, p. 12 (referred to a new genus); Nieden, Das Tierreich, Lief. 46, Anura 1, 1923, p. 328, and figs. 263 and 264 (line drawing after Günther's figure, Biol. Cent. Amer., pl. 74, fig. c [incorrect as regards terminal disks]); Kellogg, Bull. U. S. Nat. Mus., No. 160, 1932, p. 137-138 (brief notes on the types in the British Museum, and on a specimen collected by Kusche at "Venodio," Sinaloa, 4,000 ft.); Taylor, Univ. Kansas Sci. Bull., Vol. 37, 1936 (1937), pp. 514-575 (notes on topotypic specimens).

Description of species.—EHT-HMS No. 1424, topotype, collected near Presidio (Mazatlán) on the Mazatlán river. Adult male. Vomerine teeth in two raised, somewhat triangular series lying between, but extending for about half their length behind the posterior level of the choanae, closely approximated medially and separated from the large choanae by a distance somewhat less than the diameter of one group; palatine teeth very small, lying in a slightly curved transverse series behind choanae; parasphenoid teeth in an elongate median series; vocal sac median, external, causing the skin of the throat to be greatly distended and folded.

Body elongate, slender; head with a flattened bony casque, strongly concave between eyes; in front of eyes there is a low vertical crest terminating in a slightly raised, knoblike elevation above, from which the canthus rostralis extends in a sinuous line, as a slightly raised ridge joining the one from the opposite side about the level of the nostrils, and the ridge extending forward to the tip of

the snout; the sides of the casque forms a flaring crenellated edge which tends to turn up slightly, the loreal region sloping out to the flaring edge; snout projecting far beyond the mouth, the under surface shallowly concave, but forming a ridge around edge of mouth; the edge of the casque continues as a rough, slightly elevated crest back to below the tympanum, forming an angle just anterior to the eye. The posterior rugose nuchal margin flares up slightly. The entire upper surface of the casque is sculptured with radiating grooves or short reticulated grooves. Tympanum very distinct, longer than high, preceded by a small triangular patch of soft skin; on the projecting edge of the casque at a point lateral to, and slightly in advance of the nostril, is a shallow pitlike depression lacking sculpturing; on the snout near the edge and on the edges are a few fine spinelike tubercles; the under surface is smooth anteriorly, but on the sides of the mouth it is granular or slightly spinose.

Skin of body on dorsal surface smooth, with a few large granulations below and behind tympanum; ventral surfaces from pectoral region back to thighs heavily granular.

Limbs moderately long, the tibio-tarsal articulation reaching the posterior edge of the tympanum; fingers rather short, the first somewhat opposed to the others; first with a terminal disk less than a half wider than the digit; those of other three fingers nearly as wide again as the fingers. The pads are somewhat truncate with a deep groove about their outer border, and a slight transverse groove across their posterior ventral surface; a distinct vestige of a web present between fingers, continuing along edges of fingers as slight folds; subarticular tubercles low, not especially distinct; first finger with a heavy nuptual pad, covered on the dorsal surface by a deep black-brown horny excrescence, forming usually a continuum to the base of pad; toes about half webbed, the terminal disks slightly smaller than those on fingers; an elongate oval, inner metatarsal tubercle, and a slight tarsal fold; no outer metatarsal tubercle.

Color in life.—Head a rich bronze shade, more or less variegated from darker to lighter; dorsal surface of body a bright, velvety yellow-green; on the ventral surface the color is yellow-cream or cream. (In the smaller of the two specimens the under side of the spatulate snout is distinctly darker than in the other.) Under side of feet grayish, the under sides of the digital disks whitish.

After a year's preservation, the legs show very dim bands and the whole dorsal surface is ash gray to brown gray; the casque is darker, more or less brownish-gray.

Measurements of Diaglena spatulata (Günther) *in mm.*—(Measurements are of Nos. 1424 and 1423, respectively.) Snout to vent, 74, 71; length of casque, 29, 27.5; width at eyes, 22, 19; length of arm, 37.5; 36; length of leg, 87, 86; 81, 83; tibia, 28, 27; foot, 37, 35; diameter of tympanum, 3, 3; diameter of eye, 7.5, 6; width of third finger disk, 1.9, 1.8.

Remarks.—These specimens were taken under a small piece of a log on the edge of a shallow, stagnant pool. Both were crouched together, and when picked up, remained motionless.

Diaglena reticulata sp. nov.

(Plate IV, figs. 2, 2a, 2b, 2c; Plate V, fig. 1)

Type.—USNM No. 115500. Collected on the Cerro Arenal, Oaxaca, Mexico, Jan. 2, 1940, by Thomas MacDougall.

Paratype.—Amer. Mus. Nat. Hist. No. 13840, Chivela Oaxaca.

Diagnosis.—Related to *Diaglena spatulata,* but differing in having the head proportionally shorter and broader; the canthal ridges uniting farther forward and not forming a prominent nasal ridge that extends to tip of snout; skin above, granular, not smooth. The dorsal surface of body is heavily mottled with brown instead of being uniform green or olive.

Description of the type.—Head a bony casque, the skin of which is completely involved in the cranial ossification so that certain of the skull sutures are visible externally; dorsal surface roughened with small ridges or tubercles; a broad, bony ridge or "shelf" borders the sides of the head, producing anteriorly a somewhat shovel-shaped, projecting snout, the dorsal part of which is decorated with very fine, somewhat radiating ridges; thick elevated supraorbital and canthal ridges tend to enclose the depressed frontal and parietal regions; these unite between the nostrils forming a low, short, indistinct ridge; tympanum a little less than half the diameter of the eye; pupil tending to be somewhat quadrangular (although difficult to ascertain its shape in life); a postorbital ridge arches above the tympanum and connects with the very rugose ridge crossing the back part of the skull. Further skull details are shown in the figures. Eyes large, prominent, directed somewhat forward; the edge of the lateral ridges of the head are beset with tiny "teeth" or spines; these are especially conspicuous on the posterior transverse ridge.

Choanae large; vomerine teeth on two prominent triangular ridges, narrowly separated, that lie between the choanae, the teeth about on a level with or slightly behind posterior level of choanae; palatines

bearing a row of teeth; parasphenoid with an irregular, elongate patch of teeth; diastemata occur between the premaxillary series, and between the premaxillary and maxillary series of teeth; tongue broadly heart-shaped, slightly nicked behind, attached its entire length; the maxillary glands open into a sinuous groove anterior to which are two groups of several, laterally-directed minute grooves; a few rugosities (teeth) on anterior parts of the prevomers.

Skin of body lacking spines but covered, except on dorsal surface of neck (which is smooth), with fine (soft) granules which become larger on the sides; limbs with skin nearly smooth above; venter, save on chin and throat, and under surface of thigh, heavily areolate; anal flap short, narrow, the anal region surrounded by larger pustules; subanal groove distinct; posttympanic region thickened.

Arms rather thick, the toes short, with distinct terminal pads; distinct web remnant between three outer toes, forming indistinct lateral ridges on toes; tibiotarsal articulation brought forward reaching to middle of tympanum; terminal pads wider than the toes; inner metatarsal tubercle flat, small; a small outer tubercle. Other details of hands and feet indicated in the figures.

Measurements in mm.—Snout to vent, 78; width of head, 20; length of head, 28; length of snout, 14; diameter of tympanum, 2.9; diameter of eye, 6; snout projects beyond mouth, 7.5; arm, 37; leg, 88; tibia, 29; foot and tarsus, 37.

Remarks.—Very little is known regarding the habits of either this species or its related form *Diaglena spatulata*. Mr. MacDougall discovered the type ensconsed in a terrestrial bromelia. One specimen of *D. spatulata* was taken in a termite nest. Two topotypic male specimens were found by me under a log at the edge of a small pool.

Both species apparently have the habit of bending the head down so that it forms an angle to the long axis of the body. Doctor Barbour (in "Reptiles and Amphibians" 1926, fig. 99) suggests that certain related genera of frogs *Triprion, Corythomantis,* etc., may be phragmatic, utilizing the bony casque of the head to close the opening of a burrow. This habit may likewise be true of this genus.

The figure of *Diaglena spatulata* given by Günther in Biologia Centrali-Americana is, I believe, drawn from a specimen in which the terminal pads on the fingers have been dried, since the pads are shown narrower than the digits. The figure I give shows what appears to be the normal condition of the terminal pads in *D. spatulata* (drawn from a topotypic specimen).

PLATE IV

FIG. 1. *Diaglena reticulata* sp. nov. Type. U.S.N.M. No. 115500, Cerro Arenal, Oaxaca, Mexico. Dorsal view of the head. Actual length of head, 28 mm.; width of head, 20 mm.

FIG. 1a. Same, lateral view of head.

FIG. 1b. Same, under side of foot. Actual length of foot and tarsus, 37 mm.

FIG. 1c. Same, under side of hand and forearm, actual length, 32 mm.

FIG. 2. *Diaglena spatulata* (Günther). Topotype. EHT-HMS No. 1423, Presidio, Mazatlán, Sinaloa, Mexico. Head dorsal view. Actual length of head to nuchal crest, 27.5 mm.; width at eyes, 19 mm.

FIG. 2a. Same, lateral view.

FIG. 2b. Same, under surface of foot; actual length of foot and tarsus, 35 mm.

FIG. 2c. Same, under surface of hand. Actual length of hand and forearm, 28.5 mm.

PLATE IV

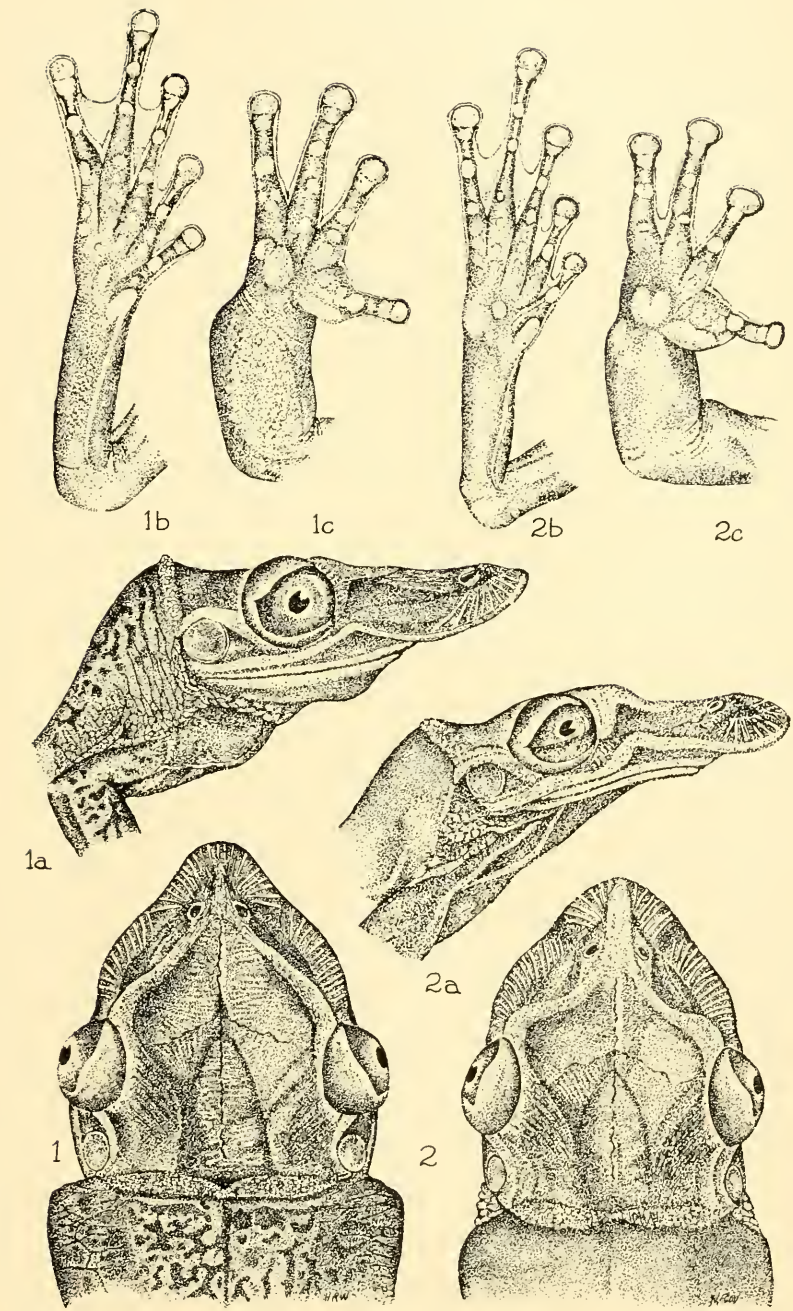

PLATE V

FIG. 1. *Diaglena reticulata* sp. nov. Type. Actual snout to vent length, 78 mm.

FIG. 2. *Diaglena spatulata* (Günther). Topotype. Presidio, 50 miles south of Mazatlán, Sinaloa, Mexico. Actual length, 74 mm.

PLATE V

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXVIII] MAY 15, 1942 [No. 5

New Tailless Amphibia from Mexico

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ABSTRACT: The following Mexican species are described as new: LEPTODACTYLIDAE. *Microbatrachylus montanus,* type locality, Mt. Ovando, Chiapas; *Microbatrachylus imitator,* La Esperanza, Chiapas; *Eleutherodactylus macdougalli,* La Gloria, Oaxaca. HYLIDAE. *Centrolenella viridissima,* Agua del *Obispo,* Guerrero; *Hyla rozellae,* Salto de Agua, Chiapas.

Centrolenella fleishmanni Boettger is reported from Mt. Ovando, Chiapas, the first Mexican record. *Hyla pheota* Cope and *Hyla leucophyllata* (Beireis) are reported from Piedras Negras, Petén, Guatemala, on the Mexican boundary. Most of the forms are figured. A figure is given also of *Eleutherodactylus mexicanus* (Brocchi).

THE specimens described or discussed are from either of two sources: The Hobart M. Smith Collection made for the U. S. National Museum, or the E. H. Taylor-H. M. Smith (EHT-HMS) collection, the property of the author, at the University of Kansas. The drawings are by Hazel R. Watson, and Robert Sudlow of the University of Kansas.

Microbatrachylus montanus sp. nov.

(Plate VI, figs. 2, 2a, 2b, 2c)

Type.—U. S. National Museum No. 115507, ♀, collected at Mount Ovando, Chiapas, 6,000 ft. elevation, April 16, 1940, by Dr. and Mrs. Hobart M. Smith.

Paratypes.—U. S. National Museum Nos. 115701, La Esperanza, Chiapas, 115702, Las Nubes; EHT-HMS No. 27846, Salto de Agua, Chiapas.

Diagnosis.—A rather large member of the genus, snout to vent measurement, 27 mm. Tympanum vertically oval, about four-fifths of the diameter of the eye. Strong fold above tympanum continued some distance on sides; no parotoid gland; a large flat inguinal

gland; tibiotarsal articulation reaching beyond the eye; an outer palmar tubercle; slight diagonal ridges across femora and tibiae. A black anal spot flanked by two yellowish-cream spots; large outer metatarsal tubercle, about two-thirds the size of large inner. Anterior wall of buccal cavity vertical; a slight diagonal ridge behind the choanae, but no vomerine teeth.

Description of the type.—Snout oval, the nostril placed closer to tip of snout than eye, its distance from tip in the distance from eye, about one and one-third times; the length of the head (9.5 mm.) slightly shorter than width of head (10.2 mm.); eye relatively small, its diameter slightly greater than its distance to the nostril; tympanum vertically oval, somewhat overhung by the very heavy, supratympanic fold, and widely separated from the eye; dorsal width of an eyelid contained nearly twice in the interorbital distance; canthus rostralis rather strongly marked, the lores very slightly concave, but broadly sloping.

Tongue a little longer than broad, not notched behind, the posterior third free; choanae nearly lateral, but visible when seen from below; there is a faint diagonal elevation posterior to the choanae, but no trace of vomerine teeth. Skin of the back with very minute corrugations, and a few minute pustules more evident posteriorly; a slight median fold can be traced the entire length; two very indistinct folds are on either side of this, arising from behind orbit; between these and the fold continued back above tympanum are two scarcely discernible ridges, one of them, however, distinct on shoulders. A prominent pustule behind the tympanum. The sides are ridged and pustulate; the ventral disk very smooth, the sides of the disk terminating posteriorly on the femora; chin perfectly smooth; dorsal surface of arms smooth; a small tubercle on the under side of forearm followed by a very slight, curving ridge and some pustules.

First finger shorter than the second; three palmar tubercles, median largest, outer small but distinct, touching the medial; terminal pads slightly enlarged; subarticular tubercles strong; a few supernumerary tubercles on palm. The hind limb short, rather thick, the heels overlapping about one millimeter when folded; surfaces above very rugose, the pustules forming distinct diagonal ridges across femur and tibia (continuous when limb is folded); anal region and about two-thirds of the under surface of the femora covered with large granules; no trace of an inner tarsal fold, but a few indistinct pustules on outer edge.

No trace of digital webs. Toes with very strong subarticular

tubercles; the tip of toes slightly widened; both metatarsal tubercles large, conspicuous, the outer nearly two-thirds the size of inner. Only a single supernumerary tubercle on sole.

Color in alcohol.—Above lavender brown of varying shades, the dorsum lighter than the adjoining lateral areas; side of snout dark lavender, with an indistinct broken line of black spots from snout to eye along the lower edge of canthus, continued along edge of lid, widening into a large spot on the supratympanic fold and region beyond tympanum; it then continues in a broken diagonal line to a point low on the side; a few black spots on lips; inguinal region light, the large, inguinal gland cream-yellow; legs indistinctly barred with dark; posterior surface of femur brownish, with minute cream flecks. A large, broadly triangular, black spot about anus, extending to under side of femora, flanked on each side of the anal region by two large irregular cream areas; two similarly colored cream spots on the heel, which, when limbs are folded, are continuous with those at the sides of anal region. Chin and throat brownish with lighter flecks. Posterior part of abdomen light, almost lacking pigment; darker flecks on the knee; undersurface of foot and tarsus dark.

Measurements in mm.—Snout to vent, 27; length of head, 9.5; width of head, 10.2; arm and hand, 15; leg, 47; tibia, 16.5; foot, 21.

Remarks.—The type is a female, with large ovarian eggs. The ovaries are pigmented.

At least four other forms of the genus occur in Chiapas. These are *Microbatrachylus albolabris, M. pygmaeus* and *M. imitator,* the last described in this paper. It may be readily distinguished from the first by the absence of the white labial stripe, from *pygmaeus* by the much greater size, the character of the tubercles and dorsal folds, and by color markings; from *imitator* by larger size, different color and the presence of the outer palmar tubercle.

Four male specimens, taken at somewhat lower elevation, are referred to this species with some hesitation. They may not be completely grown, but the condition of the testes shows them to be adult or nearly so. The tympanum in these is more circular and is proportionally closer to the eye, as is to be expected. The eye is a little larger proportionally. The outer palmar tubercles are not discernible in two of the specimens, scarcely so in the others. However, the characteristic markings about the anus and on the heels, as well as the dorsal folds and general coloration agree with the type. I think it unlikely that two species having such peculiar posterior marking would exist in the same locality.

Microbatrachylus imitator sp. nov.

(Plate VI, figs. 1, 1a, 1b, 1c)

Type.—U. S. National Museum No. 115508, collected at La Esperanza, Chiapas, May 15, 1940, by Dr. and Mrs. Hobart M. Smith.

Paratype.—U. S. National Museum No. 115700, collected at Colonia Hidalgo, 8 Km. N. La Esperanza, May 14, 1940, same collectors.

Diagnosis.—A very diminutive species of the genus, snout to vent length, 14.2 mm.; eye large, snout short, broad; a paratoid gland behind tympanum; fold above tympanum not continued; a more or less distinct dorsolateral fold from orbit to groin; diameter of the tympanum little more than half the diameter of eye; leg brought forward the tibiotarsal articulation reaches half way between eye and nostril; no dorsal fold save a faint trace of one in middle of back; inguinal gland large, flat; terminal digital pads slightly widened; inner metatarsal tubercle twice (or more) as large as outer; subarticular tubercles relatively small; no vomerine teeth. Dorsal region between dorsolateral folds whitish.

Description of the type.—Snout broadly oval; nostril almost half way between the median tip of snout and corner of eye; the length of the head and width are very nearly equal; the diameter of tympanum is contained in length of eye one and three-fourth times; length of eye about one-sixth shorter than length of snout; maxillary prominent with a shelf or groove above it; canthus rather rounded; a slight tubercle behind and slightly below tympanum.

Tongue broadly oval, not nicked behind, a little longer than broad, free behind for nearly one-third of its length; choanae somewhat lateral, but not vertically placed, visible completely when seen from below; front wall of buccal cavity concave; no trace of vomerine teeth or ridges.

Skin of the back generally smooth, but under the lens shows supratympanic fold, arises anterior to the corner of eye and is somewhat diagonally placed; this terminates at the parotoid; a dorsolateral fold, more or less discontinuous, begins behind the orbit above corner of eye, and terminates above groin; sides with some longitudinal folds or wrinkles and some minute beadlike pustules. The inguinal gland distinct, not expecially large; none or scarcely a trace of an axillary gland; chin, throat and breast smooth; abdomen with a distinct disk, broadly triangular, the sides terminating on the femora; skin of disk with minute corrugations on the outer part; surfaces of arm smooth with faint suggestion of tubercles behind wrist; leg above with fem-

ora rather smooth, but well-defined diagonal folds on the tibiae; region about anus and the posteroventral surface of femora with moderately distinct granulation.

First finger shorter than second; fingers slightly flattened with a somewhat sharp dermal edge; two palmar tubercles, the outer wanting; subarticular tubercles rather small; three other rather large tubercles on the palm; toes rather flattened, with more or less sharp dermal edges; the tips of the three middle toes minutely larger than outer toes; inner metatarsal tubercle large, somewhat flattened, with inner edge free (?); outer tubercle distinct, much less than half the size of inner. No tarsal fold, but tarsus with some wrinkling apparently due to preservation; subarticular tubercles relatively small; no supernumerary tubercles.

Color in alcohol.—Entire dorsal surface of body clay white to creamy white with a faint peppering of brownish pigment and a faint spot on occiput; sides of head and body dark but not quite uniform brown, with lighter flecks; legs barred, but the pattern of tibia does not fit that of femur when legs are folded; under surface of the body flesh with a very light peppering of brown; under surface of limb darker than venter; anal region a little darker than the posterior parts of femora.

Measurements in mm.—Snout to vent, 14.2; width of head, 6; length of head, 6; snout to arm, 6.2; arm, 8; leg, 26.2; tibia, 7.6; foot, 11.2.

Remarks.—This very diminutive species shows a superficial resemblance to *Microbatrachylus minimus*. This differs from that form in having no secondary dorsal folds, in having the inner metatarsal tubercle much larger, the outer smaller; and the absence of a conspicuous parotoid gland. I believe, however, that the two forms are related. If this type specimen is an adult, as I presume it to be, the males will probably be found to be much smaller, perhaps the smallest species known in the genus. It is presumed that males will lack vocal sacs, and have a proportionally larger tympanum.

The paratype is a very tiny specimen, rather poorly preserved and discolored. It measures 10 millimeters from snout to vent.

Eleutherodactylus macdougalli sp. nov.

(Plate VII, figs. 1, 1a, 1b, 1c)

Type.—EHT-HMS No. 27482; collected above La Gloria, Oaxaca, north of Niltepec, on an Atlantic exposure at an elevation of about 4,500 ft., Feb. 23-27, 1941, by Thomas MacDougall.

Diagnosis.—The dorsal ridges crossing on the back; the doro-

lateral ridges consisting of two or three indistinct tubercles; tarsal fold elongate, nearly half the length of tarsus; ventral disk without granulation; a white and a dark stripe on under surface of tibia.

Description of type.—Snout rather pointed, with a distinct canthus rostralis; eyes moderately prominent, the width of an eyelid (2.55 mm.) much less than interorbital width (3.4 mm.); greatest diameter of tympanum (3 mm. wide, 3.25 mm. high) about 4/5 to 5/6 of eye length (3.8 mm.); distance from eye to nostril (3.3 mm.) a little less than length of eye; length of snout, 4.9 mm.

Tongue subcircular, thick, not or but very slightly nicked behind, attached for four-fifths of its length; vocal sacs apparently wanting, as no openings are visible; choanae somewhat lateral, not hidden when seen from below; vomerine teeth on posterior part of two elongate, raised areas separated from each other by a distance about equal to width of one series, the teeth much posterior to choanae, although the raised areas reach to near their posterior borders.

Skin smooth on head and anterior part of body, minutely granular on the posterior part; a pair of ridges arising near posterior corners of eyelids, cross on the back and terminate at a point above end of ilia; dorsolateral dermal ridges running back from eye are indicated by a few small tubercles; a skin fold from eye passes above the tympanum, and is continued along the side of the body to groin; a faint trace of a median dorsal ridge on body; sides more or less granular, without trace of inguinal or axillary gland. A well-defined disk on venter not reaching the femora; skin of disk transversely wrinkled but not areolate or granulate, the edges forming well-defined folds; two small tubercles behind tympanum and an indistinct branch of the supratympanic fold passing down behind tympanum. Dorsal surface of femora and tibia somewhat rugose, ventral and posterior surface granular in region below anus. Throat and breast smooth.

Tibiotarsal articulation reaches a little beyond tip of snout; when limbs are folded at right angles the heels overlapping 3.5 mm.; toes slender with somewhat widened tips and terminal grooves; subarticular tubercles strong; inner metatarsal tubercle relatively moderate, less than one-half of the distance between tubercle and end of first toe; a small but distinct outer tubercle; a very narrow inner tarsal fold begins behind tubercle and extends about half the length of the tibia; an outer tarsal fold faintly indicated, extending the length of the tibia; toes with rather sharp lateral edges; a faint trace of webbing between bases of toes. First finger longer than second on left hand (on right hand equal to second, apparently abnor-

mally); outer palmar tubercle partially fused with the medial; subarticular tubercles large; a few supernumerary tubercles present.

Color.—Light gray dorsally, the snout being of a somewhat darker bronze-gray. A black median spot at the juncture of the ridges; a pair of dark spots on the rump; a black spot on anterior part of upper arm and a broken dark stripe on under side of forearm; side of snout dark; the lip indistinctly black and white spotted; a black spot involves tympanum; transverse bars on limbs almost obsolete; chin, breast and under surface of limbs with brownish pigment; a dark and light line under the tibia; heel and under surface of foot dark; dark spots on knee; a triangular dark area about anus.

Measurements in mm.—Snout to vent, 27; width of head, 12; length of head, 13; axilla to groin, 11; arm, 16; leg, 48; tibia, 16; foot, 18.3.

Remarks.—This species, superficially resembling *Eleutherodactylus rhodopis*, differs in a number of characters. In *rhodopis* the dorsal ridges do not meet and cross; dorsolateral ridges are usually distinct; the ventral disk is more or less granulate; the tarsal fold is reduced to a tubercle.

E. rhodopis is distributed in the lowlands in eastern Mexico from the state San Luis Potosí, through Veracruz, Oaxaca and Chiapas. It has been reported from eastern Central America as far south as Costa Rica. I presume that *E. macdougalli* is a restricted mountain form.

Gadow in his "Through Southern Mexico," tells of finding *E. rhodopis* at 10,000 ft. elevation on Citlaltepetl. I am inclined to question this identification of the frogs he observed there, since all the specimens of *E. rhodopis* examined (more than 100 from numerous localities) have been obtained at relatively low elevations.

The species is named for its discoverer.

Eleutherodactylus mexicanus (Brocchi)

(Plate VIII, figs. 2, 2a, 2b, 2c)

Leuiperus mexicanus Brocchi, Bull. Soc. Philom. Paris, Ser. (7), I, No. 4, p. 484 (Type description; type locality, Mexico).

A series of specimens from Lachiguiri, Oaxaca, collected by Mr. MacDougall have much reduced vomerine teeth and most of the other characters are typical. The type has the vomerine teeth in two minute clusters. The arrangements of the median dorsal folds to form the subcircular figure (shown in Plate VIII, fig. 2) is dim or wanting in other specimens of the series.

CENTROLENELLA Noble

The genus *Centrolenella* comprises a group of species of tiny arboreal frogs, with a range extending from southern Mexico to the northern Andes of South America. Noble has pointed out that this genus has T-shaped terminal phalanges and at the same time the intercalated digital cartilage and seem to combine certain characters of the *Hylidae* and *Leptodactylidae*. The genus *Centrolene* Espada is similar in these respects. These two genera have been variously assigned to the two families. Thus Nieden, Das Tierreich, Anura I, pp. 369-370, 434-435, refers *Hylella fleishmanni* [= *Centrolenella fleishmanni*] to the genus *Hylodes* and *Centrolene geckoideum* to the genus *Centrolene* under the family CYSTIGNATHIDAE = LEPTODACTYLIDAE, while certain other species referable to one or another of the two genera are placed in the *Hylidae*. Noble in his "Biology of the Amphibia" (1931) places both genera in the family HYLIDAE.

Dunn (Occ. Papers Boston Soc. Nat. Hist., 5, 1931, p. 398) points out variation in the vomerine teeth in *C. prosoblepon* and *C. pulverata*. Whether this variation is due to age as is true in *Hyla smithi* I cannot say. Individuals of *smithi* are large when they transform and many of the young specimens approaching the adult in size may lack vomerine teeth. I believe that in this species they are invariably present in old adults.

I regard the presence of the humeral hooks in male *Centrolene* a character of sufficient importance to maintain that genus separate from *Centrolenella* which lacks the hooks in both sexes.

Centrolenella fleishmanni Boettger

Hylella fleishmanni Boettger, Bericht. Senck. Ges. 1893, p. 251; Günther, Biologia Centrali-Americana, Rept. Batr.; Sept., 1901, p. 287, pl. 73, fig. D.

A single specimen of this species was collected by Dr. and Mrs. Hobart M. Smith on Mount Ovando, Chiapas, in 1940. This is the first record of the genus in Mexico. Its presence is not surprising since specimens have been obtained in Petén, Guatemala (Michigan No. 79025). These two specimens agree in having the tibiotarsal articulation reaching several millimeters beyond the snout when brought forward. The iris is silver (golden in life?) with some purple flecks. The dorsal surface is a very light cream or flesh (originally green?) with a fine peppering of reddish purple or violet. There is a cream spot on the upper eyelid.

Centrolenella viridissima sp. nov.

(Plate IX, figs. 2, 2a, 2b)

Type.—EHT-HMS No. 27725 ♂ ; collected at Agua del Obispo, Guerrero, August 2, 1941, by Edward H. Taylor.

Paratypes.—EHT-HMS Nos. 27719-27724; 27726, 27727. Topotypes.

Diagnosis.—Very small frogs, the known maximum size, 23 mm. in male. Related to *C. fleishmanni,* but with shorter, stouter limbs and shorter, wider digits; tibiotarsal articulation does not or barely reaches tip of snout while in *fleishmanni* it reaches much beyond.

A large vocal sac, the slits within mouth, large; no vomerine teeth; skin above covered with minute, irregular granules; abdomen covered with large granules; pupil horizontal; anal flap very broad; two outer fingers half webbed; none or only a trace of web between first three fingers; toes nearly four-fifths webbed; an elongate inner tarsal fold; tympanum concealed; color on all dorsal surfaces bright leaf green, below transparent flesh.

Description of type.—Outline of head, seen from above, rounded, the eyes not extending beyond outline; head not especially depressed; eyes directed somewhat forward, the anterior corner of eye nearly directly behind and on a slightly higher level than nostril; no canthus rostralis, the snout rounded, the lores sloping rather broadly to the lip without concavity; region about nostrils somewhat elevated, with a slight depression between them; the upper lip extends minutely farther forward than nostril, the line between edge of lip and nostril nearly vertical; tympanum concealed, a slight irregular depression suggesting its position; interorbital distance greater than an eyelid; distance between anterior corners of eyes about one-half distance between the posterior corners; a slight fleshy thickening above tympanic region and above arms; an indistinct folding of skin along the sides of body (may be due to preservation).

Entire dorsal surface of body and exposed dorsal surface of arm and leg covered with minute rugosities or granules of irregular size and shape, scarcely discernible without magnification; abdominal surfaces with large, well-defined granules, which are largest posteriorly; on under surface of thigh the granules are somewhat less distinct, tending to form transverse series, with shallow grooves between; on the medial posterior edges of thighs there are two short thickened glandular folds or protuberances.

Internal nares large, more dorsal than lateral in palate; tongue (normally) subcircular, slightly free behind, slightly emarginate;

basal cartilage of the larynx with (apparently) a free, somewhat triangular edge (visible when mouth is opened widely); the vocal sac large, the slitlike openings at sides of tongue; the skin very amply folded on chin and strongly wrinkled at neck; breast smooth, without folds or granules.

Upper arm very slender; without any trace of a humeral cartilage; forearm thickened; fingers short, broad, the distal dilations very little if any wider than digits themselves; subarticular tubercles moderate, flat, that of outer digit tending to be double; first two fingers somewhat opposed to the other two; an indistinct fleshy ridge under forearm; two outer fingers half webbed; a web remnant between second and third, none or only a mere trace of a web between first and second fingers; leg moderately fleshy, the tibiotarsal articulation not or barely reaching tip of snout; when limbs are folded at right angles, the heels touch; toes about four-fifths webbed, except fourth which has two joints free; a rather large, flat, inner metatarsal tubercle; a small, indistinct outer; an elongate inner tarsal fold, not strongly defined; first finger very slightly longer than second, but the two placed side by side appear to be of the same length; surface of hand and foot with a few granulations other than the tubercles; the median palmar tubercle rounded, the inner flat, elongate, rather indistinct; outer toe a little broader than third, the tips not or but little wider than digits.

Color.—In life bright leaf green; concealed parts of limbs and ventral surfaces transparent flesh; the intestine, visible through the abdominal wall, cream yellow to white. The eyeballs are very black. Preserved in alcohol the specimen became a still lighter green and then a bluish-green, while the surfaces below became paper white. The dorsal surfaces, except on upper arm and thigh, have a fine peppering of pigment which is lavender to reddish purplish in color and scarcely discernible as long as the green color remains. There are some whitish flecks visible on back and on the upper surfaces of forearm and tibia.

Measurements in mm.—Snout to vent, 21.1; head width, 8.8; head length, 7.5; arm, 13; leg, 35.5; tibia, 12; foot, 15.

Remarks.—After specimens have been in preserving fluids some time the green fades, light spots appear and the chromatophores which are of a purplish or lavender color are discernible against the light background. There are usually no chromatophores on the dorsal surface of the limbs. However, in two specimens there are one and three minute chromatophores, respectively, on the upper surface of the thigh.

This species, while related to *Centrolenella fleishmanni*, differs from it in a number of points. Thus in *C. fleishmanni* the heel reaches much beyond the snout; the upper parts are smoother, the head is broader proportionally; the iris of the eye is golden instead of black; the choanae are much larger, and there are no fleshy folds below anus or thigh.

The specimens were collected at night in the midst of fine rain. They were on leaves of trees growing in the gulch that carries away the water of the spring at Agua del Obispo. They were discovered through their call, which is a short whistle. The call is given once and then may be repeated after an interval of one-half to one minute. The call is reminiscent of the call of *Syrrhophus* or *Microbatrachylus*, rather than that of any *Hyla* I know.

Specimens were clinging to the wet, shiny, tree leaves and their color blended so perfectly with the leaves that I was able to discern their presence only when they raised the head to call, at which time the vocal sac, being of a light color, was visible. Nine specimens were taken, although many more were heard, for the most part among the higher branches and out of reach of my lantern light.

This particular gully had been visited a number of times previously (twice on rainy nights), but the calls of this species had not been heard nor any specimens found. However, specimens of *Hyla erythromma* had been taken. Three of the *Centrolenella* were found together with a single *Hyla erythromma* in one tree where on a previous visit I had found only the latter species.

The rancho, Agua del Obispo, consists of some three or four houses near a spring. The surrounding hills are covered sparsely with pine forest with little or no undergrowth. The general locality had in the past been found to be exceedingly rich in species and specimens. In 1936, I alone collected some thirty-two species of reptiles and amphibians in one day.

On this last journey (1941) I found that most of the country had been burned over during the previous year, and most of the fallen logs and other debris that offered shelter to the animals had been destroyed. By contrast, in a day's collecting at the same time of year, only seven species were taken.

Hyla rozellae sp. nov.

(Plate IX, figs. 1, 1a, 1b, 1c)

Type.—U. S. National Museum No. 115039. Collected at Salto de Agua, Chiapas, by Dr. and Mrs. Hobart M. Smith.

Paratypes.—U. S. National Museum Nos. 115038, 115040-115051. Topotypes. Same collectors.

Diagnosis.—Eye shorter than snout; tympanum exposed, its diameter less than half length of eye; tibiotarsal articulation half way between eye and nostril; three outer fingers a little more than half webbed; toes nearly fully webbed, the membrane reaching almost to the disk, save on fourth finger, and inner side of second; first finger strongly opposing other three. No vocal sac in male.

Related to *Hyla loquax* and *Hyla rickardsi,* but differing from these by the absence of the axillary web, strongly pigmented posterior femoral region; the diameter of tympanum narrower than its distance from eye (in *loquax* and *rickardsi* width of tympanum much more than distance from eye). The chin is granular, rather than smooth and the vocal sac is absent.

Description of the type.—Head as long as wide, broadly oval; canthus moderately sharp, extending across the elevated region above the nostrils and terminating in a point anterior to nostrils; loreal region concave, then flaring broadly to edge of lip; nostrils nearer eye than tip of snout, but there is very little difference in the distance from middle of nostril to median anterior edge of upper lip, and the distance to eye. Eye large, elevated, directed slightly forward, the lid tending to cover back part of eyeball; the lower eyelid apparently shorter than usual in the genus; width of the upper eyelid contained in interorbital width, one and one-half times; tympanum distinct, nearly circular, the skin covering it minutely granular, separated from the eye by a distance one-fourth greater than its diameter. The supratympanic fold distinct, narrow, overhanging the tympanum slightly; area between the nostrils somewhat concave; tongue subcircular, very slightly nicked behind, attached completely; vomerine teeth on two elevated, transverse ridges between choanae, reaching to anterior level but not to posterior level of choanae, and separated from them by a distance somewhat greater than distance between the ridges. Choanae much larger than the vomerine ridges; groove for mucous gland lies transversely, midway between choanae and anterior part of the palate, the groove tending to curve back in middle and at the ends.

Skin above minutely corrugated but without pustules; ventral surfaces covered with granules, those on chin smaller than those on venter; anal region granular, the anal flap not especially elongate.

Disks on digital tips moderately dilated; first finger strongly opposed to other three; a much enlarged tubercle at base of first finger; other palmar tubercles small, rather indistinct; distal subarticular tubercles large, that of the outer finger divided; palm of hand irregularly granular; web very slight between first two fingers. A well-defined tubercular fold on outer under surface of forearm.

Disks on toes smaller than those on outer fingers, the webs extending almost to the base of the disks on the outer side of the three first toes, and the inner side of the fifth. Inner metatarsal tubercle large, the anterior part elevated; outer tubercle very small, situated anterior to level of the inner tubercle. Web between toes and sole of foot granular. A rather indistinct inner tarsal fold, not reaching the inner metatarsal tubercle.

Color.—Above mottled, vinaceous brown, the pigment reduced on hands and feet. Some cream spotting on the sides, the darker color forming an indistinct reticulation. Front face of femur pigmentless, the posterior face rather heavily pigmented; under surface of tarsus pigmented; jaw lighter than remainder of head with a still lighter lip; ventral surfaces cream.

Measurements in mm.—USNM Nos. 115038, 115039; sex ♂, ♀ ; snout to vent, 33, 43.5; width of head, 10, 14.5; length of head, 10.6, 14.4; axilla to groin, 16, 24; arm, 19.2, 25.7; leg, 48, 69; tibia, 16, 23; tarsus and foot, 21.2, 29; diameter of tympanum, 1.6, 2; length of eye, 3.8, 4.5.

Remarks.—The remainder of the paratypes are all recently transformed young. In these the tongue is circular and not visibly notched behind. The web on the toes is somewhat less extensive.

The relationship is, I believe, with *Hyla ricardsi* and *Hyla loquax.* The following key will assist in differentiating the forms:

A. A vocal sac present, with a strong web from arm along the side. Tympanum wider than its distance from eye.
  B. Posterior femoral region unpigmented, red in color; canthus rostralis wanting, the snout rounded.....*Hyla loquax.*
  BB. Posterior femoral region pigmented. A distinct canthus present..*Hyla rickardsi.*
AA. No vocal sac; web scarcely discernible in axilla; tympanum much narrower than its distance from eye.....*Hyla rozellae.*

The species is dedicated to Mrs. Rozella Smith, who assisted in collecting the type series.

Hyla leucophyllata (Beireis)

Rana leucophyllata Beireis, Schr. Ges. Fr. Berlin, 4, 1783, p. 182, pl. 41, fig. 4 (not seen).
Hyla ebraccata Cope, Proc. Acad. Nat. Sci. Philad., 1874, p. 69 (Nicaragua).

The status of Cope's *Hyla ebraccata* from Nicaragua, described as a color variety of *Hyla leucophyllata,* has never been adequately decided. It has been thrown into synonymy of the latter and there has remained. I do not have available sufficient material from southern localities to determine the matter to my own satisfaction. In consequence I am referring to the older species a series of specimens of a small frog collected by Dr. and Mrs. Hobart M. Smith at Piedras Negras, Petén, Guatemala. As this locality is on the Usumacincta river, which forms a part of the boundary of Mexico, this form must be reckoned as a part of the Mexican fauna.

The series contains the following numbers: USNM Nos. 111148-52; EHT-HMS Nos. 12632-33.

If this species is correctly referred to *Hyla leucophyllata* it represents a considerable northern extension of range of the species.

Hyla phaeota Cope

(Plate VIII, figs. 1, 1a, 1b, 1c)

Hyla phaeota Cope. Proc. Acad. Nat. Sci. Phila. 1862 (1863?) p. 358-359. (Type description; type locality, Turbo, Columbia.)

A series of Hylas collected by Dr. and Mrs. Hobart M. Smith at or near Piedras Negras, Petén, Guatemala are, I believe, the northernmost record for this species. This locality is on the Usumacincta river, which borders the Mexican state of Chiapas. It is reasonable to suppose that the species occurs across the river in Chiapas and should be reckoned a member of the Mexican fauna.

I have not examined the type, but the specimen agrees well with the type description save for three points. The canthus is relatively distinct rather than "rounded"; the tongue is somewhat emarginate posteriorly instead of "entire"; and the third toe has two phalanges of the fourth toe free instead of "nearly three." I doubt that these differences are more than relative and in a measure may be a matter of interpretation.

The reticulation on the sides and on the anterior and posterior sides of the femur is usually very distinct. Doctor Smith's notes give the following data on coloration. No. 111147: "Dorsal ground color dark tan, the darker markings darker brown; a fine cream line down canthus; a rich brown (slightly reddish) band below canthus through eye, expanding posteriorly to cover tympanum and terminat-

ing above axilla; bright green below this on loreal region and below eye; a slightly golden, cream line from above axilla around labial region and snout; another rich brown band below this bordering lip; sides of body coarsely reticulated with dark brown; upper part of light lateral area on body green, lower part (in groin) light blue; anteriorly the lower part of the light lateral area is green, except a little behind axilla, where it is white; concealed surfaces of thighs rich, dark wine color, with profusely scattered, round spots of light blue; a narrow border of green on upper edge of concealed surfaces of thighs on proximal third (nearly half); light marks on anterior surface of thigh and on concealed surfaces of tibia and foot, very light brown or white; under throat dirty brown, with small white spots; belly lighter; under side of hind limbs light wine color."

A second specimen is mentioned which lacks the blue color on sides, the dorsal coloration being brown.

Several of the specimens have a bifurcating mark on the shoulder and a black bar between the eyes as mentioned in the type description.

The life colors have faded and no trace of the blue remains at this time.

PLATE VI

FIG. 1. *Microbatrachylus imitator* sp. nov. Type. U.S.N.M. No. 17137. La Esperanza, Chiapas. × 2.

FIG. 1a. Same. Side of head. × 3.

FIG. 1b. Same. Under side of hand. × 3.

FIG. 1c. Same. Under side of foot. × 3.

FIG. 2. *Microbatrachylus montanus* sp. nov. Type. U.S.N.M. No. 14772. Mt. Ovando, Chiapas, elev. 6,000 ft. × 2.

FIG. 2a. Same. Side of head. × 3.

FIG. 2b. Same. Under side of hand. × 3.

FIG. 2c. Same. Under side of foot. × 3.

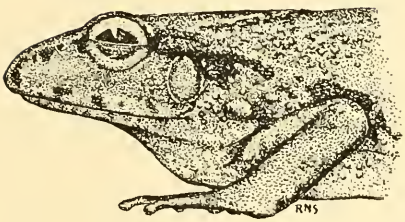
PLATE VI

1

1b

1c

1a



2a

2c

2b

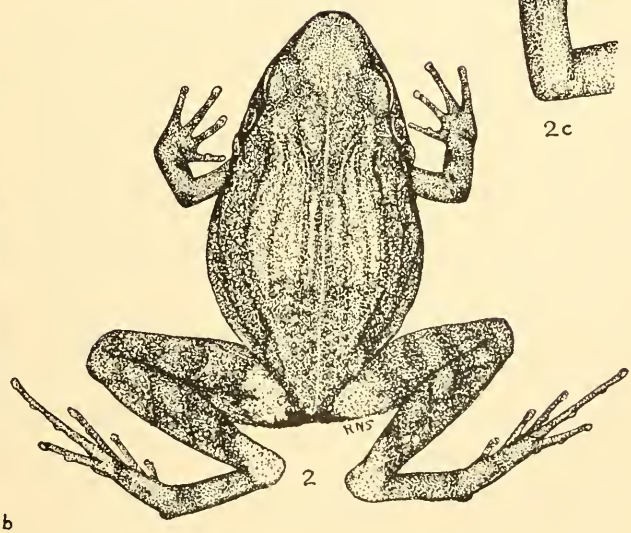


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PLATE VII

FIG. 1. *Eleutherodactylus macdougalli* sp. nov. Type. EHT-HMS No. 27482. La Gloria, Oaxaca, elev. 4,500 ft. × 2.

FIG. 1a. Same. Side of head. × 3.

FIG. 1b. Same. Under side of hand. × 3.

FIG. 1c. Same. Under side of foot. × 3.

PLATE VII

PLATE VIII

FIG. 1. *Hyla phaeota* Cope. EHT-HMS No. 27847. Piedras Negras, Petén, Guatemala. (Actual snout to vent length, 52 mm.)

FIG. 1a. Same. Side of head (enlarged).

FIG. 1b. Same. Under side of hand (enlarged).

FIG. 1c. Same. Under side of foot (enlarged).

FIG. 2. *Eleutherodactylus mexicanus* (Brocchi) U.S.N.M. No. S. 12752. Lachiguiri, Oaxaca. (Actual snout to vent length, 33 mm.)

FIG. 2a. Same. Side of head (enlarged).

FIG. 2b. Same. Under side of hand (enlarged).

FIG. 2c. Same. Under side of foot (enlarged).

PLATE VIII

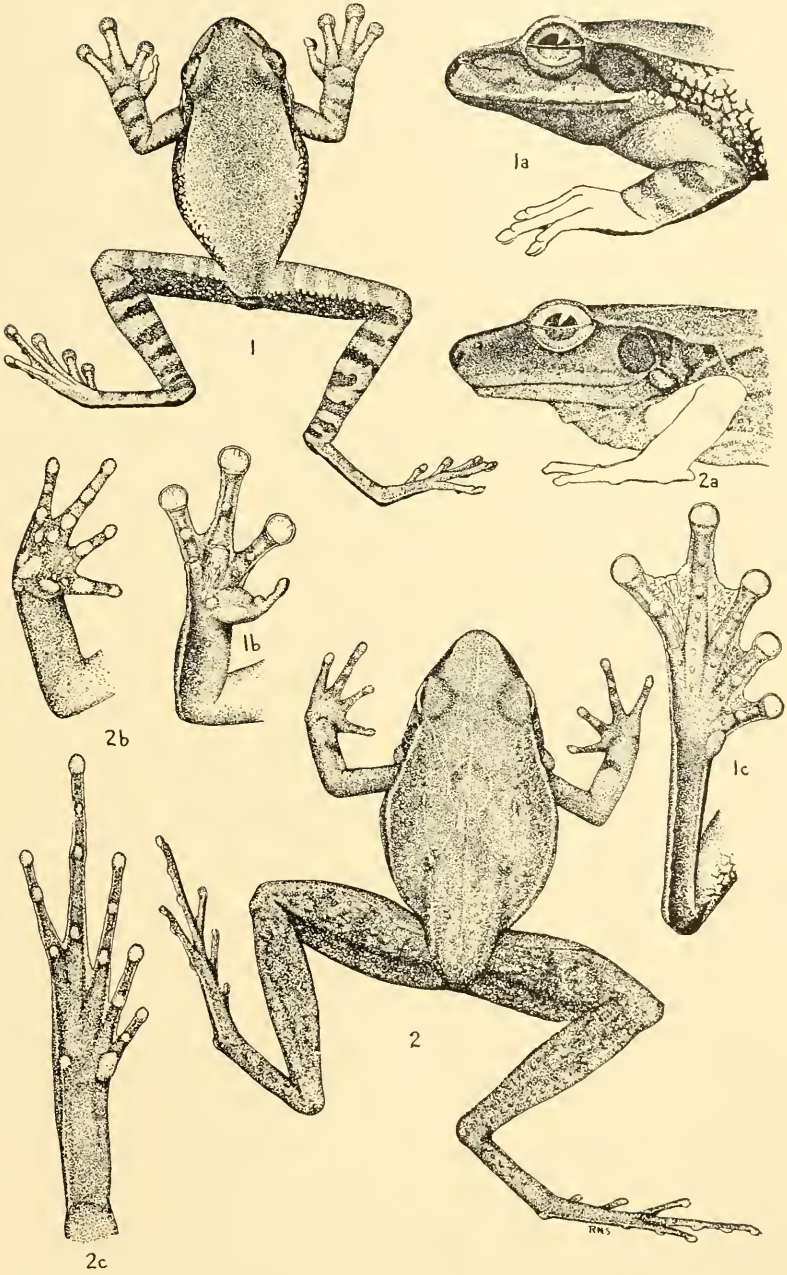


PLATE IX

FIG. 1. *Hyla rozellae* sp. nov. Type. U.S.N.M. No. 115039. Salto de Agua, Chiapas. × 1.

FIG. 1a. Same. Side of head. × 2.

FIG. 1b. Same. Under side of hand. × 2.

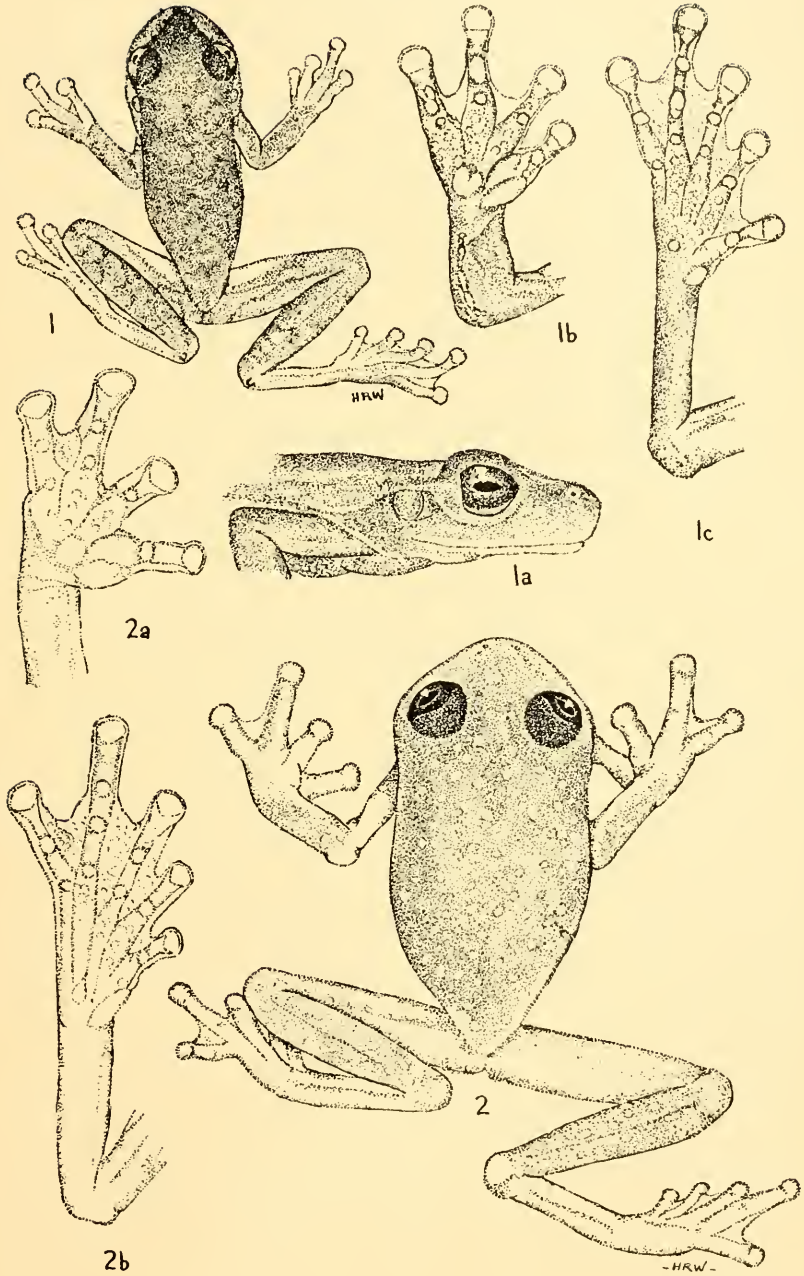
FIG. 1c. Same. Under side of foot. × 2.

FIG. 2. *Centrolenella viridissima* sp. nov. Type. EHT-HMS No. 27725. Agua del Obispo, Guerrero. × 3.

FIG. 2a. Same. Under side of hand. × 4.

FIG. 2b. Same. Under side of foot. × 4.

PLATE IX



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Some Geckoes of the Genus Phyllodactylus

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ABSTRACT: The members of the genus *Phyllodactylus* occurring in Mexico are discussed. Three new species are described as follows: *Phyllodactylus bordai* from near Taxco, Guerrero, Mexico; *Phyllodactylus magnus* from Tierra Colorado, Guerrero, Mexico; *Phyllodactylus darwini*, Chatham Id., Galápagos Islands. The Central American species *Phyllodactylus ventralis* O'Shaughnessy, the South American *Phyllodactylus reissi* Peters, and the Mexican *Phyllodactylus unctus* (Cope) are discussed. All specimens are figured.

MUCH of the older literature dealing with the genus *Phyllodactylus* in Mexico and Central America is confused, owing to the fact that most specimens reported upon have rather indiscriminately been referred to *Phyllodactylus tuberculosus* Wiegmann.

This species was described by Wiegmann in a section devoted to "Amphibien" in "Beiträge zur Zoologie, gesammelt auf einer Reise um de Erde" by J. J. F. Meyen, Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol., 17 (1) 1835, pp. 241-242, pl. 18, figs. 2, 2a. The work deals with the reptiles and amphibians of the "Reise," but this species purporting to have originated in "Californien" seems quite out of place, since the itinerary of the Reise passed no closer to California than the Galápagos Islands or Honolulu. The type locality "Californien" has been understood to refer to Baja California since a large, tubercled species does occur there.

Cope (1863) described two species from peninsular Mexico. One *Diplodactylus unctus,* a species well differentiated from *Phyllodactylus tuberculosus* by the absence of trihedral tubercles on the back, was described as having a snout to vent length of 4.5 inches (110 mm.). The other species was named *Phyllodactylus xanti,* a species having large tubercles on the back. This species was referred to the

synonymy of *P. tuberculosus* by O'Shaughnessy (1875) and there it has remained.

Hobart M. Smith (1935) recognized in the Mexican *Phyllodactylus* which we had together collected in Mexico, two species of the genus neither of which resembled *P. tuberculosus* Wiegmann sufficiently to be regarded as the same species. These he named *P. homolepidurus,* type locality, "five miles southwest of Hermosillo, Sonora," and *P. lanei,* type locality, Tierra Colorada, Guerrero.

Smith in his paper suggested that there was no certainty that *P. tuberculosus* Wiegmann actually came from "California." The following year W. Mosauer (1936) described a species *Phyllodactylus delcampi* with the type locality Tierra Colorada, Guerrero. He expresses the opinion that there should be no question as to the type locality of *tuberculosus* and suggests that it might have been purchased "preserved in a bottle from a sailor." He erroneously places *P. lanei* in the synonymy of *P. tuberculosus* apparently on the strength of a specimen in his possession so labeled. He mentions "great variability" in *P. tuberculosus,* which strongly suggests that he had more than a single species so labeled. Mosauer's opinion should be given no more credence than those expressed by Smith, since he saw no specimen unquestionably *P. tuberculosus.* Until the type of the Wiegmann species is rediscovered and studied by a competent person, there will be doubt as to which form must bear the name *tuberculosus.* Even then the matter may not be settled, since the type has a regenerated tail and the characters of the original tail are pertinent in defining the species of the genus.

Recently (Taylor, 1940) I described two other species of the genus. These were *Phyllodactylus muralis* from Totolapam, Oaxaca, and *P. magnatuberculatus* from Acapulco, Guerrero.

The EHT-HMS collection of *Phyllodactylus* now numbers about 250 specimens. The identified specimens in the collection are referred to the following forms:

30 specimens *Phyllodactylus homolepidurus* Smith
58 specimens *Phyllodactylus muralis* Taylor
96 specimens *Phyllodactylus lanei* Smith
4 specimens *Phyllodactylus bordai* sp. nov.
21 specimens *Phyllodactylus delcampi* Mosauer
21 specimens *Phyllodactylus magnus* sp. nov.
1 specimens *Phyllodactylus magnatuberculatus* Taylor

In this paper I describe two new species from Mexico and a third from Chatham Island, Galápagos Islands. The last species has been identified previously as *P. tuberculosus.*

I am not aware that any lacertilian species has such a distribution as has been attributed to *Phyllodactylus tuberculosus* (California to Peru) without the aid of man. Wide distribution occurs in domestic geckoes, such as *Peropus mutilatus* and *Hemidactylus frenatus,* but so far as I know no evidence has been marshalled to prove that *P. "tuberculosus"* is a species of this sort. I do not doubt that still other undescribed forms occur in Mexico, some of these already in museum collections, masquerading under the name *tuberculosus.*

The status of certain Phyllodactyli in California, Baja California, and the islands of the west coast of Mexico must remain in doubt until further study can be made. Two names are to be reckoned with—*Phyllodactylus xanti* and *Phyllodactylus tuberculosus,* both belonging to the group having the large tubercles on the back, and presumably enlarged tubercles on the tails.

At least one undescribed form is known to occur, this on Isla Sta. Margarita, off the west coast, and doubtless others occur elsewhere. These forms are to be treated in another paper.

A species from an unknown locality, *Phyllodactylus mentalis* Werner (Jahrb. Hamburg Wiss. Anstalt., 27 (2), 1910, pp. 4-5) described from a poorly preserved specimen that had apparently "died in captivity and was greatly emaciated" cannot be associated with any known Mexican species with certainty. Mosauer (1936) adds a few details to this description.

Phyllodactylus bordai sp. nov.

(Fig. 1)

Type.—EHT-HMS No. 27732, collected about six miles north of Taxco, Guerrero, Mexico, under rock, at an elevation of about 5,600 ft., August 26, 1941, by E. H. Taylor.

Paratypes.—EHT-HMS Nos. 10997, 6 Km. south of Taxco, Guerrero, July 17, 1936; 21808, near Agua Bendita, Guerrero, August 27, 1939; 27733, topotype.

Diagnosis.—Less than eighteen scales between middle of orbits exclusive of scales on eyelids; sixteen more or less irregular rows of trihedral tubercles; tail covered with regular flat transverse rows of scales without enlarged scales or tubercles; postmentals touch one labial; auricular opening distinctly denticulate; enlarged scales of front face of femur encroaching on dorsal surface with one to three larger tubercular scales bordering them; dorsal and posterior faces of femur granular.

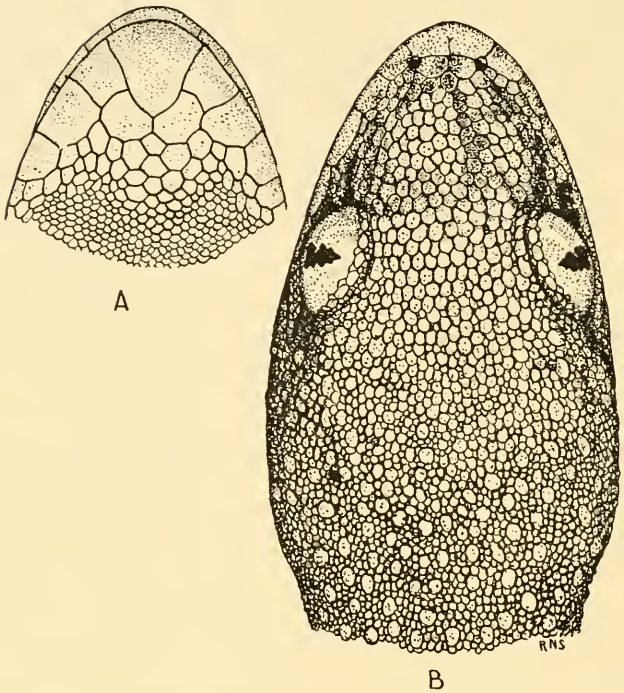

FIG. 1. *Phyllodactylus bordai* sp. nov. Type EHT-HMS No. 27732. A. Chinshields; B. Dorsal view of head. Both enlarged.

Description of type. — Head not greatly flattened, somewhat wedge-shaped; neck constricted; a slight constriction in outline of head below eye; loreal region inflated, the edge of the upper jaw somewhat shelflike; none or only a very slight depression behind the nostril; a shallow depression in the interorbital and frontal regions; rostral about once and a half as wide as high with a Y-shaped median groove entering above; nostril surrounded by the rostral, first labial, two postnasals and an internasal; latter large, about as wide as long, in contact with its fellow, but partially separated posteriorly by a median scale; seven upper labials to below middle of pupil, these followed by five very small poorly differentiated scales; five lower labials to below pupil followed by a small differentiated labial and three undifferentiated scales; fifteen scales between middle of orbits, eleven between anterior corner of orbits; three or four small rows of granules and an outer series of palpebral scales that grow smaller posteriorly; posterior scales of the series bordering lid pointed, but not spinelike; twenty-two scales across snout between

fourth labials, eighteen between third labials across snout; scales bordering labials flat and somewhat imbricate; eye moderate, its diameter contained in snout length slightly more than one and one-half times; auricular opening small, denticulate; in occipital region the scales are about the size of the interorbital scales, intermixed with a few smaller granules; mental subtriangular, the anterior curving labial edge greater than that of the rostral; postmentals in contact narrowly, touching two labials and followed by six scales; body granular above with fourteen to sixteen irregular rows of trihedral tubercles, of which eight or ten extend on the neck and eight reach base of tail; about thirty rows of scales cover the abdomen, turning up slightly at the ventrolateral edge.

Upper arm with flat imbricating scales on anterior and dorsal surfaces; granular on posterior and ventral surfaces; forearm with flat imbricating scales on anterodorsal face, granular with numerous enlarged trihedral tubercles dorsally. On ventral and anterior surfaces of femur, large imbricate scales which encroach on the dorsal surface and three of the scales of the outer row are enlarged tubercles; posterior part of femur granular; dorsal surface of lower part of leg granular with three irregular longitudinal rows of tubercles.

The lamellar formula for hand, 7-9-10-11-9; for foot 7-10-12-13-12; many of the lamella (two or more on each digit) are divided, sometimes in three, sometimes in two, parts; terminal lamella pads are longer than broad, the outer anterior edges somewhat rounded; four lateral postanal tubercles.

Tail (from EHT-HMS Nos. 21808, 10997) indistinctly annulated, the scales arranged in transverse series, their edges rounding or truncate posteriorly; fifty-four broad scales under tail.

Color.—Above grayish with narrow, irregular, transverse lighter lines (about nine from head to base of tail); an indistinct line from tip of snout through eye with other dim markings on snout, and a whitish spot in front of orbit; below white, with a fine peppering of dark pigment; digits banded dark and light; tail with eight dark bands.

Measurements in mm.—Snout to vent, 44; width of head, 9; length of head, 13; arm, 13; leg, 17; axilla to groin, 23.

Remarks.—This species was collected first in 1936 and recognized as new. The single specimen taken at that time was very young, measuring about 27 millimeters snout to vent, and having a total length of 55 mm. Believing that it would be an easy matter to obtain other specimens, I visited this region in 1938, but no specimens

were found. In 1939 a single specimen was taken from under loose bark on a tree, this only slightly larger than the first; again in 1940 the general region was visited but no specimens were found; but in 1941 somewhat north of Taxco, two specimens were obtained from under limestone rocks superimposed on other limestone rocks. These also were juveniles.

The hills in the type locality are covered with limestone which juts above the surface in innumerable places appearing as separate masses or isolated boulders. These often have small cavities where the rock has been dissolved away, leaving excellent hiding places for the lizards that are practically inaccessible to the collector. It is probable that the species is plentiful in the region.

I do not know the adult size of this species, but suspect it to be about that of *Phyllodactylus muralis* (snout to vent, 60 mm.). It differs from that form in the absence of the enlarged tubercles on the tail, larger scales between orbits (13-16, as compared with 22-26 in *muralis*), and the presence of denticulate scales in the small auricular opening. Most of the other species, in Guerrero, have whorls of enlarged tubercles on the tail; *P. lanei* has the dorsal part of femur granular with large conical tubercles scattered on the dorsal femoral surface. There are about the same number of interorbital scales in the two forms. *P. magnus* has nearly double the number of scales on the head as *P. bordai*, smaller series of ventral scales and whorls of caudal tubercles. It differs from *P. magnatuberculatus* in much the same way it differs from *P. lanei*. From *delcampi* it differs in color and markings; it agrees in the absence of caudal tubercles but has larger dorsal tubercles and is a much smaller species. The elevation at which this species has been taken (5,000-6,000 ft.) is greater than that for other Mexican species.

The species is named for Joseph le Borde (or Borda), the fabulously wealthy silver miner of Taxco.

Phyllodactylus unctus (Cope)

(Fig. 2)

Cope (1863) described *Diplodactylus unctus* from a specimen (USNM No. 5304) sent to the Smithsonian Institute by John Xantus. The type locality is Cape St. Lucas, Lower California. The original measurements given are: length from end of muzzle to auricular meatus, 12‴ [lines]; from the same point to vent, 4.5″ [inches]. These measurements were given in a later work (Cope, 1900) as 25 mm. and 110 mm., respectively, which, if correct, are of a species

larger than any North American form known today. Most of the collected specimens referred to this species are small.

Van Denburgh (1912, p. 417) states concerning *P. unctus*, "The natives do not distinguish this from the larger *P. tuberculosus*, but on account of its small size call it *Salamanquesa chiquita*."

Two specimens from "Isla Ballena near Espiritu Santo"; Baja California, which I have been permitted to examine through the courtesy of Mr. Karl P. Schmidt of the Field Museum, are likewise small, but obviously adult. In consequence I suspected some error in the measurements. Dr. Doris Cochran, to whom I wrote requesting data on the type and submitting a drawing of an Isla Ballena specimen, supplied the following information:

"The type of *Phyllodactylus unctus* (Cope) is [USNM] No. 5304. From snout to anterior ear it measures 7.5 mm.; snout to vent, 29 mm. The top of our type's head is quite similar to your drawing. Our type has five upper and five lower labials before they become small and beadlike; yours taper off less soon. The chinshields are not similar, as you can see by my sketch of the type. The hind leg and posterior dorsal region seems similar."

The species most closely resembling *Phyllodactylus unctus* in squamation is *Phyllodactylus leei* from Chatham Island, Galápagos Islands. That species lacks enlarged tubercles among the granular body scales as does *P. unctus*. The two forms may be distinguished from each other by the presence in *unctus* of large postmentals touching each other and in contact with two labials (in *leei*, small postmentals touch one labial and are in contact or not); in *unctus* the scales under tail are broader and there is a smaller number of scales in a whorl around tail; the internasals are larger and in contact (smaller and separated frequently in *leei*); the scales on the head are smaller and more numerous in *P. unctus*, while the body scales are a little larger.

Despite the apparent similarity, it is highly probable that *P. unctus* is derived from a mainland species and is not directly related to the Chatham Island species. I believe the relationship to be with the group of small species that includes *P. muralis* and *P. bordai*. The probable relationship might be expressed, *muralis* — *bordai* — ? — *unctus*.

P. bordai appears to have lost the enlarged caudal tubercles entirely while the smaller caudal scales in the three species are very similar. In *delcampi* the enlarged caudal tubercles are missing and the enlarged dorsal tubercles are much reduced in size.

The figure given by Cope of the underside of the chin of a Triunfo, Baja California specimen (1900, *loc. cit.*, p. 461), shows three postmentals in contact with the mental, which is the more frequent arrangement in *P. lecl* according to Van Denburgh (1912, p. 417).

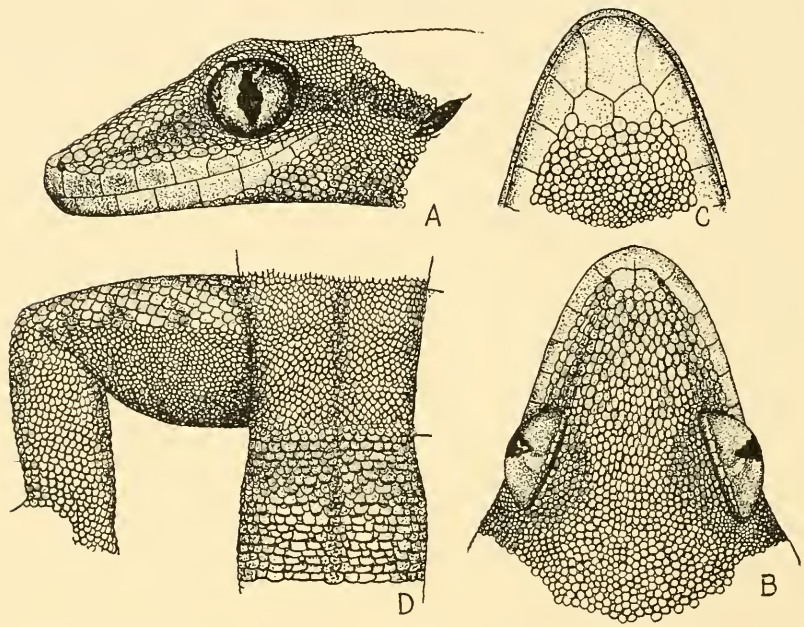

FIG. 2. *Phyllodactylus unctus* (Cope) Field Museum No. 16104. A. Lateral view of head; B. Dorsal view of head; C. Chinshields; D. Squamation of basal caudal region and hind limb. All enlarged.

The figures given for this form (Field No. 16104 snout to vent, 35 mm.) are slightly diagrammatic, but show most of the characters of the form. The following characters obtain: About 83 scale rows surrounding the middle of body, of which some 31 may be regarded as ventrals, although those on the outer edges of venter are small and merge gradually into the smaller dorsals; subcaudals widened, those near base are alternately single and paired for first 12 scales. Lamellar formula for fingers, 7-8-10-12-9; two or three distal lamellae are paired or divided into three parts. Lamellar formula for toes, 7-8-9-12-11; part of the distal lamellae are divided as in the fingers; ear lacking distinct denticulations; 21 scales between middle of orbits, 12 scales between anterior part of orbits ignoring the minute granules near eye; 28 scales between fourth labials, 19 between third labials across snout; annuli on tail consist of four, rarely five, rows

of scales above, while below there are but 2 medially and these bordered by three scales. The enlarged scales of the front face of femur cover half of the dorsal surface. Outer posterior palpebral scales each tipped with a small dermal spine.

Most of the other scale characters are indicated in the figures.

The body has five rather broad transverse bands of brown; the tail has twelve, which are narrower than the intervening light spaces; digits spotted or banded with brown.

Phyllodactylus magnus sp. nov.

(Fig. 3)

Type.—EHT-HMS No. 21783, collected at Tierra Colorada, Guerrero, September 2, 1939, by Edward H. Taylor.

Paratypes.—EHT-HMS Nos. 11047-11049, Garrapatas, Guerrero; 21765-21767, El Ocotito, Guerrero; 21768-21771, 21784-21786, Tierra Colorada, Guerrero; 11038-11044, Agua del Obispo, Guerrero; 11035, Tonolá, Chiapas; USNM, Nos. 115707-115712, Tehuántepec, Oaxaca; 115740-115750, Cajon de Piedra, Oaxaca; 115738-115739, Escurana, Oaxaca; 115713-115717, 115718-115724, 115760, Tres Cruces, Oaxaca; 115725-115737, 115703-115705 Cerro Arenal, Oaxaca; 115751-115756 Tonolá Chiapas.

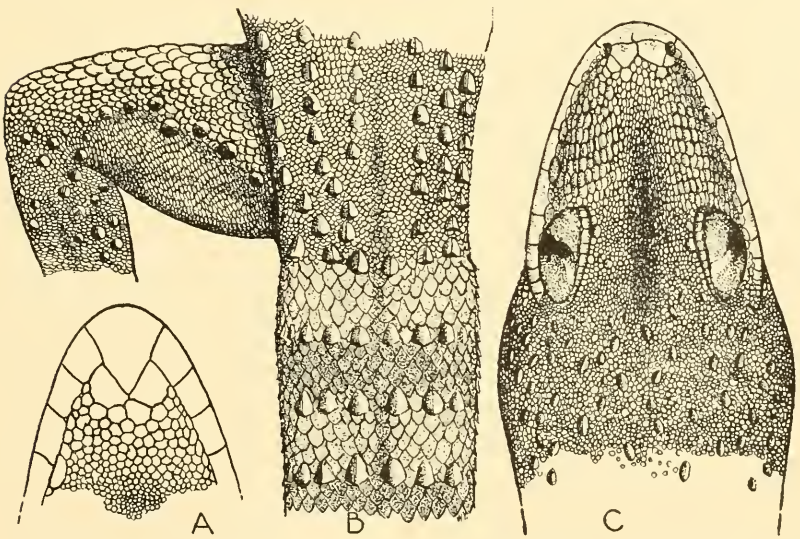

FIG. 3. *Phyllodactylus magnus* sp. nov. EHT-HMS No. 11035; Paratype Tonolá, Chiapas. A. Chin scales; B. Basal caudal region and hind limb; C. Dorsal view of head. All enlarged.

Diagnosis.—A large species, maximum snout to vent measurement about 90; ventral surfaces brilliant canary yellow; 14-16 rows of dorsal tubercles, none in contact; 25-30 scales between middle of orbits, not counting 4-5 rows on each eyelid; large flat imbricating scales on anterior face of femoral region encroaching strongly on dorsal surface, with a few elevated scales or trihedral tubercles along the posterior edge of flat scales; basal annuli of tail with transverse series of six large keeled scales separated by about four irregular rows of small scales; 28-32 scales across snout between fourth labials; postmentals large, normally touching two labials, followed usually by six or seven scales; subdigital lamellae dark, single except for a distal pair preceding the terminal pads; auricular opening not denticulate.

Description of the type.—Head flattened, bluntly wedge-shaped viewed from the side; head widened behind eyes, equaling or exceeding body width; a slight constriction in outline of head below posterior corner of eye, seen from above; loreal region slightly inflated with a slight depression immediately in front of orbit, and another behind nostril; frontal and interorbital region with a wide shallow depression; a slight groove between the internasals; twenty-nine tubercular scales between orbits with two or three larger tubercles on outer edge; four or five small granular series on eyelid with a series of larger palpebral scales, growing smaller posteriorly; scales on outer face of lid becoming pointed posteriorly; at least one or two rows on under side of the eyelid; the occipital region covered with small granules intermingled with larger tubercles somewhat bluntly conical; snout covered with large, thick, convex scales about thirty-three across the snout between fourth labials, twenty-eight between the third labials; about fourteen scales in a row between the orbit and the nostril; rostral a little more than twice as wide as high with a straight groove entering from upper edge, half as wide as the scale; two large internasals separated by small scales (in most specimens the internasals are in contact), each entering nostril as does the rostral; two postnasals, the upper largest, and the first labial also borders nostril; about fifteen upper labials, diminishing in size from the first which is as high as wide; six labials to below eye pupil, the last labials not differentiated from body scales; ten lower labials, first two higher than wide, five anterior to a point below pupil; the three following of equal size, the last two somewhat conical; mental five-sided, longer than wide, the sides bordering labials concave, the convex, curving, labial edge much greater than the rostral edge; a

pair of postmentals in contact medially, touching two labials laterally and followed by seven scales, the median largest (a portion of the second labial is partially segmented on the right side, and a corner is segmented in two pieces from the other); the mental, pointed behind, extends farther back than first labials; eleven in the second row, sixteen in third; sixty-seven scales across throat between ears.

Back with fourteen rows of trihedral tubercles among the small granular scales, the inner rows regular, the outer ones irregular; two or three small tubercles, low on side, suggest the beginning of two more rows (frequently sixteen rows present); 26-28 rows of flat imbricate scales across the belly, the outermost separated from lateral tubercles by three or four rows of granules; sixty rows from anterior level of arm to anus; posterior edge of ventral scales indistinctly denticulate; three or four small lateral postanal scales; leg reaches beyond elbow of adpressed arm; upper arm almost covered with large flat imbricated scales, with a few granules on posterior side; a few granules on upper surface of forearm with larger tubercles intermingled; large flat scales cover ventral and anterior face of thigh and encroach on the dorsal surface; a few trihedral tubercles border the larger scales; posterior face of thigh granular. Tail annulate, each annulus consisting of a series of enlarged keeled scales, and four or five other rows of small irregular scales rounded or pointed behind; distal part of tail regenerated, the scales very irregular, lacking tubercles; under surface of tail with broad plates of two types which alternate, one narrower but longer transversely, the other wider and shorter transversely; the adjoining scale row on each side irregular; two equal scales alternate with one somewhat smaller and set somewhat out of the row; lamellar formula: 6, 9, 12, 12, 10; only the distal lamella divided; a pair of large lamellar plates at tip of digits, the outer anterior edges of which are rather angular; lamellar formula for toes: 8, 10, 12, 13, 12; only the distal lamella divided; terminal pads similar to those on fingers. Claws largely concealed.

Color.—Above brownish-gray with indistinct, irregular, paired, black spots about ten from head to base of tail; a few other indefinite dark specks on head and sides of body; tail indistinctly banded at base, the regenerated part bluish-gray with some irregular lighter marks; ventral surface bright lemon yellow; lamella and terminal pads dark gray, a slight peppering of dark pigment on venter; lips with darker and lighter spots.

Table of measurements and scale counts of Phyllodactylus magnus sp. nov.

Number	21783	11047	11048	11049	21765	21766	21767	21768	21769	21770	21771	21784	21785	21786	11038	11039	11042	11043	11044	11035
Sex	♂	♂	♂	♀	♀	♀	♂	♂	yg.	♂	♂	♀	♀	♀	♀	♂	♀	♂	♀	♀
Snout to vent	86	79	67	71.5	82	71	71	88	41	80	86	82	83	79	66	89.5	81	43	71	81
Snout to orbit	9.8	9.1	8	8.1	9.7	8	8.1	10	5.5	8.7	10.9	9	9	9.2	8	10.1	9.1	5.1	8	9
Snout to ear	21.3	20	16.5	18	21.5	17.6	18.3	22.6	11	21	22	20	20	20	17.4	21.5	20	12	18.5	20
Snout to foreleg	34	31	25.2	31	31	30	29	35	19	34	33	31	32	32	26	32	32.2	20	27.5	32
Axilla to groin	38	38.1	32	37.5	38	32	31	42	17.5	38	42	40	41	38	32.8	40.5	37	23	33	38
Width of head	19	16	14.1	15.2	17.2	14.3	14	19	9	17	17	16.5	17	17	14	17	17	10	14	17
Length of head	24	23.2	20.3	22	25	20.3	20.4	24	12.2	23	23.5	22	23	22.5	20.5	26	24	14	22	22
Arm	26	25	22	26	22.5	22	23	28	13	24	26.3	25	25.5	24	22.5	28	27.6	15	22.5	24
Leg	35	33	28.5	33	34.5	26	30	36.5	15.5	31	37	31	32	34	29.5	38.6	32.5	18.2	32	30
Scales between orbits	29	26	28	26	26	27	26	25	28	28	26	25	26	26	27	21*	23	24	28	28
Scales across abdomen	28	28	27	24	25	26	26	26	25	26	28	25	26	25	23	24	26	24	27	27
Postmentals touch labials	2–2	2–1	2–2	2–2	2–2	2–2	1–1	2–2	2–2	2–2	2–2	2–2	2–2	2–2	2–2	2–2	1–1	2–2	2–2	1–1
Scales follow postmentals	7	9	7	9	7	7	8	6	6	6	7	8	6	6	7	7	8	7	6	8
Scales between fourth labials	33	32	32	31	33	29	29	30	28	30	30	30	28	30	29	33	31	31	38	33
Rows of tubercles	7–7	7–7	7–7	7–7	7–7	7–7	8–8	7–7	?	7–7	8–7	7–8	7–8	7–7	8–8	7–8	7–7	7–7	8–8	8–8
Scales orbit to nostril	14	13	15	14	14	13	13	12	12	12	12	13	12	12	14	13	13	12	14	14

* Injured and scales regenerated.

Variation.—The major variations in squamation are indicated in the table. Males have somewhat larger and heavier tubercular scales on the back and the tails are thicker at the base. In the series of specimens available several of the males have the dark spots a little larger than in type and they seem to contact others, suggesting a reticulum. Three of the specimens have the internasals separated by small intercalated scales. Two or three specimens had some of the lighter scales reddish-brown. The yellow color of venter is characteristic of the species and is always present save in very young specimens. One specimen from the pine region near Agua del Obispo has the median spots elongated and in a linear arrangement.

The specimens from various localities in Oaxaca and Chiapas show some variations not observable in those from Guerrero. There is some tendency to reduce the number of the enlarged caudal tubercles posteriorly. In one or two specimens the smaller caudal scales were somewhat truncate rather than pointed and arranged in somewhat straighter transverse rows. Specimens having heavier spots tending to form a body reticulum were present also in the Oaxaca and Chiapas specimens.

Compared with *Phyllodactylus lanei* from the same region this species differs in having a much larger series of interorbital scales, 23-29, average, 25.7 as compared with 14-19 with an average of about 15.7; scales across the abdomen are about 26 on the average in *magnus,* while those of *lanei* average about 30; usually the subdigital lamellae (except the outer one) are undivided, in *lanei* usually three to five are divided in two or three parts; the upper dorsal part of leg is partly covered with large, flat, imbricate scales, with a few tubercles bordering the larger scales, in *lanei* the dorsal surface of the leg is granular with eight or more scattered large, conical tubercles. The ventral surface is flesh to white in *lanei.* The three large species, *P. lanei, P. magnus,* and *P. delcampi,* are not closely related. They occupy the same habitats. I have found *lanei* and *magnus* in the same crevice while *magnus* and *delcampi* have been taken in the same pile of boulders. No specimens of *Phyllodactylus lanei* have been taken in the state of Oaxaca to my knowledge.

Phyllodactylus darwini sp. nov.

(Fig. 4)

Phyllodactylus tuberculosus Cope, Proc. U. S. Nat. Mus., XII, 1889 (Feb. 5, 1890), p. 145, Chatham Is. USNM Nos. 14949, 14956; Garman, Bull. Essex Inst., XXIV, 1892, p. 9 (Chatham I; "This identification may yet be questioned. The specimen in the collection, from Chatham, is badly mutilated"); Heller, Proc. Washington Acad. Sci., V, Feb. 26, 1903, p. 60 (Data on specimens mentioned by Cope *loc. cit.*); Van Denburgh, Proc. California Acad. Sci., Ser. 4, I, Apr. 16, 1912, pp. 412-413 (21 specimens from Chatham I, No. 10848 described).

Type.—California Academy of Science No. 10848, coll. Chatham Island, Galápagos Islands, by Joseph R. Slevin, Jan. 27, 1906.

Paratypes.—C. A. S. Nos. 9909-9913, 9915, 10021, 10024, 10025, 10032, 10838-10840, 10866-10868, 10877, 10995, 11013, 11992, 11954 topotypes; USNM Nos. 14949, 14956. Topotypes.

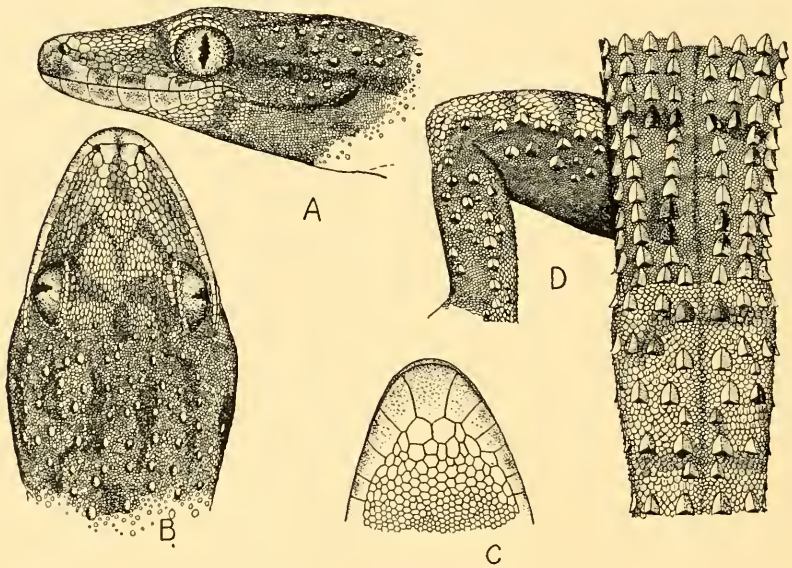

FIG. 4. *Phyllodactylus darwini* sp. nov. Type California Academy of Science No. 10848, Chatham Id. Galapagos Islands. A. Lateral view of head; B. Dorsal view of head; C. Chin scales; D. Basal caudal region and hind leg. All enlarged.

Diagnosis.—A medium-sized species of the genus; the known maximum size, 72 mm. snout to vent; 12-14 rows of large trihedral tubercles, those of the rows posteriorly usually in contact, while those farther forward separated by one or more scales; 93 to 105 granules across head between ears; scales across snout between fourth labials 23-28; mental large, bordered by two postmentals; tail with whorls of enlarged trihedral tubercles, which are separated by several irregular transverse rows of small granules. Usually a pair of trihedral

tubercles between the whorls, occasionally four such scales; irregular scales between orbits. Ventral and ventrolateral scales not well differentiated.

Description of the type.—Head moderately flat, bluntly wedge-shaped viewed from the side; head distinct from neck which is somewhat constricted; none or only a slight constriction in outline of head below eyes; loreal region somewhat inflated save for a slight depression anterior to lower part of eye, and a slight depression posterior to the nostril; anterior part of interorbital region and frontal region slightly concave; interorbital scales between middle of eyes 18-20, outermost row with three or four enlarged tubercles; fourteen enlarged scales between anterior part of orbits not counting granular scales; eyelids folding back under the supraorbital region, covered above with three to four rows of granules and bordered by a row of large scales diminishing in size posteriorly; the scales of row on outer edge of lid are somewhat pointed or spinose posteriorly; two rows of scales on the front and under surface of the lid; ten or eleven larger scales between orbital depression and nostril; scales bordering upper labial slightly imbricate posteriorly; about twenty-three scales between third labials, twenty-six between fourth labials, across the snout. Rostral much more than twice as wide as high, with a Y-shaped groove entering from above; a pair of internasals; two postnasals behind nostril; nostril bordered by these four scales and the first labial; six or seven labials diminishing in size to a point directly below middle of eye, followed by two or three smaller labials which are not strongly differentiated from body scales, and five as small as body scales; edges of snout not flattened out forming a shelf; five or six lower labials to a point below eye, diminishing in size posteriorly; behind these there are two larger and four very small scales; mental large, subpentagonal, bordered by a pair of postmentals which touch each other and only a single labial; mental border of lip distinctly larger than rostral border; a row of six irregular scales border the postmentals, the outermost touch first and second labials; forty-six scales between jaws at level of eye, those bordering the labials, largest.

A few small, low conical tubercles begin on the occipital region, becoming larger in parietal and temporal region; on neck begin six rows of trihedral tubercles forming twelve rows at middle of body with a few scattered tubercles outside these; outer tubercles on posterior part of back heavy, distinctly larger than the median rows; between hind legs there are eight rows anteriorly, becoming six pos-

teriorly, scales in the outer rows are usually in contact anteroposteriorly, separated by from one to three minute scales laterally; the median rows of tubercles are separated by twelve to fourteen minute scales between hind legs. The ventral scales are moderately large, not strongly differentiated from the lateral scales at ventrolateral region of midbody; those on sides smaller but they diminish gradually in size and the scales are less flattened, about forty between the outermost laterally enlarged tubercles; across breast they are better differentiated and here there are about thirty-two ventral scales. No ventrolateral fold; nor can a ventrolateral glandular region be distinguished.

Tail longer than head and body, annulated, sixty-three scales (or pairs of large scales) under tail; beginning at the base, scales alternately narrower, with greater transverse length, and wider with a lesser transverse length; this difference in shape increases, the narrower (longitudinal) scales becoming somewhat bilobed; later these are replaced by paired scales alternating with the unpaired ones and at tip all are paired; there are two of the large scales to an annulus, the medial series bordered by a series of large scales in which two scales of equal size alternate with a smaller scale, this arrangement not so obvious at the tip; each annulus above covered with three or four transverse rows of small scales and a transverse row of six or eight enlarged trihedral tubercles, the median scales largest; between these rows are medial pairs of trihedral tubercles at first equally spaced, then set closer to the following row; farther back there may be four or six larger scales in the intercalated rows; lateral caudal scales less elevated than dorsals.

Limbs of moderate length, the adpressed leg reaching beyond elbow of the adpressed arm; anterodorsal surface of arm with equal flat imbricating scales; scales equal but much smaller and granular on under surface; forearm anteriorly with flat scales, dorsally with a patch of granules intermixed with large trihedral tubercles; under surface of forearm with scales larger than those on under surface of upper arm. Lamellar formula for hand: 7, 10, 12, 12, 9; the distal scales forming a pair of lamella, and the one adjoining this is divided on first three fingers into two or three parts; lamellar formula for toes: 8, 12, 13, 13, 12; distal lamella divided; on second and third toes, the one or two adjoining lamellae also divided; large terminal flaps (not counted) divided medially, their outer, lateral, anterior edges somewhat rounding; claws largely concealed; ventral surface of leg and the anterodorsal face of femur covered with flat imbricate

scales; posterior and posterodorsal parts covered with granules intermixed with enlarged trihedral tubercles.

Eye large, the pupil a vertical slit with irregular edges. The auricular opening a diagonal slit, lined with slightly enlarged scales. On the posterior part of many scales on body and tail there is a slight or distinct denticulated posterior edge. A small smooth upper anal flap, the edge scarcely free, a row of three or four small lateral postanal scales; openings of cloacal pores visible.

Color.—Dorsal surface yellowish gray, with a somewhat regular series of brown spots or lines on head; the brown markings on back tend to form a reticulum; legs and arms dimly reticulated; a dark stripe from snout to eye, and from eye to above ear, above which there is an indistinct lighter stripe; labials with brown spots; thirteen darker bars on tail; below yellowish white with a slight peppering of brown pigment.

Measurements in mm.—Nos. 10995, 10848, respectively: sex, ♂, ♀; snout to vent, 72, 61.5; snout to eye, 8.2, 8; snout to ear, 18.6, 15.5; snout to arm, 30, 23.8; axilla to groin, 34, 26; tail, ?, 70; arm, 22.5, 22; leg, 30.5, 27.5; width of toes, 1.8, 1.8; diameter of orbit, 3.7, 3.5; rows of tubercles, 14, 13; scales between ears, 102, 93; scales between orbits, 17, 20; scales across snout between fourth labial, 28, 26.

Variation.—Van Denburgh (1912) gives some data on the variations occurring in this species. There is some difference in the elevation of the dorsal tubercles which may be due to age. Some of the median dorsal tubercles have more conspicuous dorsal keels and appear much smaller than outer scales.

Remarks.—When this species is compared with *Phyllodactylus lanei* of the same size the following differences are evident in the latter. The mental is much larger, less emarginate laterally, and extending farther back; the enlarged postmentals are in contact usually with two labials; the toes are broader and the posterior dorsal tubercles are not contiguous; the granules on back of femur are nearly twice the size of those in *darwini;* scales on the tail are larger, flatter, while the trihedral tubercles are arranged in simple transverse series usually of six scales; the lateral glandular folds are very prominent and the dorsal markings are pair quadrangular brown spots.

Compared with tuberculated species of *Phyllodactylus* from Baja California and adjacent islands, the following differences obtain: The mental is smaller, narrower, not extending so far back; the ear opening is smaller, of different shape, and has denticulations; enlarged scales present between the transverse tubercular rows on tail.

Other differences are obvious on a comparison of specimens or descriptions.

The species is named for Charles Darwin, a traveller who once visited the Galápagos Islands.

Phyllodactylus ventralis O'Shaughnessy

(Fig. 5)

Phyllodactylus ventralis O'Shaughnessy, Ann. Mag. Nat. Hist., (4), 16, 1875, p. 262. (Type description; type locality, Jamaica [probably in error].)

This very poorly described species has been reported from Jamaica (doubtful type locality), Colombia and Nicaragua. O'Shaughnessy compared the form with *Phyllodactylus tuberculosus,* but what he interpreted as *P. tuberculosus* is not known.

Two specimens belonging to the U. S. National Museum (Nos. 89480-89481) were collected on the aviation field at Managua, Nicaragua. They have been dried somewhat and some of the characters have been made out with difficulty. Probably because of their condition they had been mistakenly referred to *P. tuberculosus.*

The major characteristics of one of these specimens is given in the somewhat diagrammatic figure. The part of the tail figured is regenerated.

The following characters obtain in USNM No. 49480, Managua, Nicaragua: Groove in rostral straight, not Y-shaped; scales between posterior parts of third labials across snout, 21; between middle of orbits, not counting scales on eyelids, 16; scales between orbits nearly as large as those on the snout; on parietal region, large, moderately elevated, conical tubercles with some smaller tubercles between; about 40 large and small tubercles between auricular openings across occipital region; auricular openings not denticulate, probably somewhat curving in life or slightly triangular, rather vertically placed; about 13 to 15 scales between ear and orbit; 10 to 11 between orbit and nostril; the usual 5 scales surround nostril; 5 upper labials to below pupil; the labials low, elongate, about twice as long as high, five lower labials to same point; mental bell-shaped, reaching back as far as first labials, followed by two postmentals about as large as first labials; these followed by four scales in first row and ten in second row; 12 to 14 rows of dorsal tubercles which are nearly as wide as long on back; the rows are irregular and there is no widened median area without tubercles; upper arm and forearm with large imbricating scales, those of the latter smaller; dorsal surface of hind leg with cycloid imbricating scales without tubercles;

lamellar formula for hand: 7, 8, 10, 11, 8; for foot: 7, 9, 10, 12, 10, occasionally one of the proximal lamellae is divided; of the distal lamellae, the one just following the divided terminal pad, is paired; about 22 to 24 enlarged scale rows across venter; about 51 transverse rows from neck to anus. About 48 scales across throat between lower part of auricular openings; four lateral postanal tubercles on each side. The tail is regenerated in this specimen.

The smaller specimen has the original tail, but this is shriveled. The scutes are large, arranged in annuli consisting of a row of larger scales and two or three smaller rows; scales under tail, large, not paired, two to each annulus; the keels on the dorsal scales are indistinct in the dried specimens.

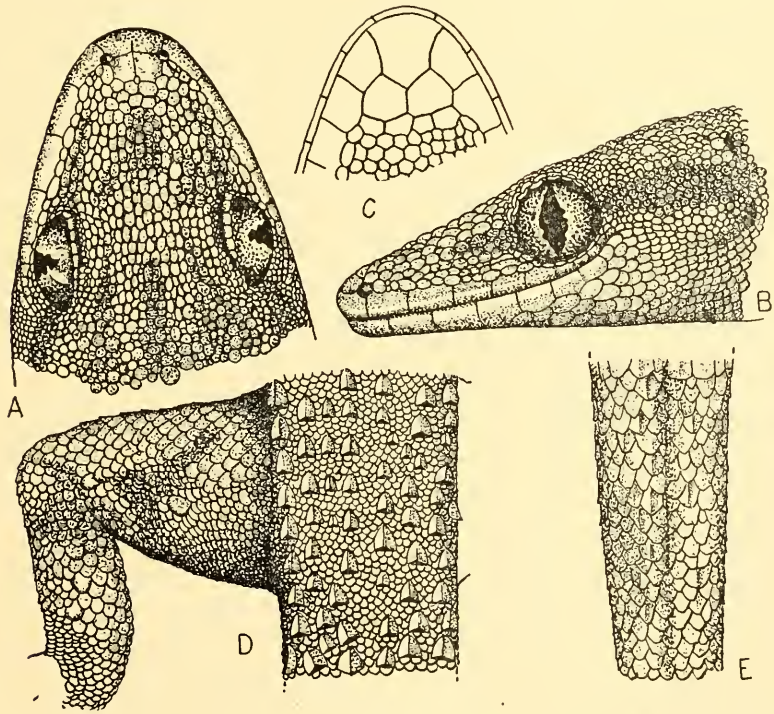

FIG. 5. *Phyllodactylus ventralis* O'Shaughnessy. U. S. Nat. Mus. No. 89480, Managua, Nicaragua. A. Dorsal view of head; B. Lateral view of head; C. Chinshields; E. Portion of tail (regenerated). All enlarged.

Phyllodactylus reissi Peters

(Fig. 6)

Phyllodactylus reissi Peters, Monatsb. Königl. Akad. Wiss. Berlin, Nov., 1862, pp. 626-627. (Type description; type locality, Guayaquil, Ecuador.)

The literature on this species other than the type description consists of very few references. It has recently been suggested that the type locality is incorrect. The probabilities are, however, that it is correct.

I am referring a specimen in the U. S. National Museum, No. 12354 from Guayaquil, Ecuador, (catalogued as *Phyllodactylus tuberculosus*) to this species. I have not examined the type, but this specimen agrees rather well with the very few scale characters given in the type description. The enlarged tubercles on the back are not broader (or but occasionally so) than the intervening granular spaces between them. They appear to the naked eye actually narrower. The mental is almost wholly between the adjoining infralabials and followed by two rounding (actually, nearly hexagonal) scales; there are 14 longitudinal rows of closely approximated tubercles on the back, the rows regular. The scales in the occipital region at least in the middle part are without enlarged tubercles. However, there are a few slightly enlarged ones on the sides of the back of the head, all, however, smaller than the scales on the snout. The specimen is so faded that I cannot say whether the markings are the same as those of the type, but presume that originally they were the same.

The following characters obtain in USNM No. 12354: Rostral much wider than high, with a straight median groove entering from the posterior edge, followed by two enlarged scutes which are separated medially by two small scales; nostril surrounded by five scales, the two postnasals somewhat larger than adjoining scales of the snout; about 28 scales between the fourth labials across snout; snout scales somewhat oval, slightly elevated laterally but flattened medially; 12 to 14 scales between orbit and nostril; about 26 scales between middle of orbits not counting scales on eyelids; scales on sides of back of head with a few slightly enlarged tubercles; about 65 granules between the auricular openings across the head; ear more vertical than horizontal, surrounded by sharp denticulate scales; seven or eight upper labials to a point below pupil; seven lower labials to the same point; mental slightly campanulate; the two median chinshields touch only the first labials and are bordered by six scales, the two outer of which likewise touch first labial, and also touch the second; about 27 longitudinal enlarged imbricate scales across the abdomen; about 55 transverse rows from a line drawn

between front part of the arms to anus; the anterior and most of the dorsal surface of arm with rather large imbricate scales; anterior face of femur and the anterior dorsal part of same with enlarged imbricate scales without any enlarged tubercles; posterior face with minute granules; a few scattered tubercles on lower part of leg. The terminal pads widened, somewhat angular, followed by a paired lamella. The two lamella that follow these may be divided in two or three parts. The remainder of the subdigital lamella, wide and undivided.

The tail is wanting so that the very important caudal characters cannot be recorded.

The figure given of this form is somewhat diagrammatic. The scales on the snout are slightly larger than depicted and a trifle more regular. The scales between the orbits are much more regular, especially those directly above the orbits. The shape of the pupil cannot be exactly determined.

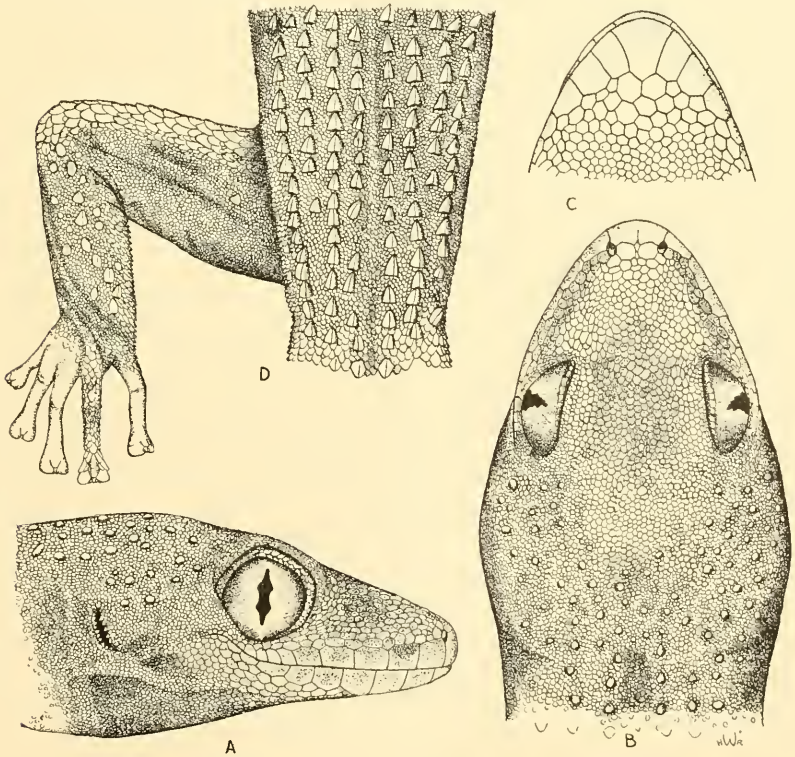

FIG. 6. *Phyllodactylus reissi* Peters. U. S. Nat. Mus. No. 12354, Guayaquil, Ecuador. A. Lateral view of head; B. Dorsal view of head; C. Chinscales; D. Posterior part of body and hind limb. All enlarged.

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Gerrinae in University of Kansas Collections*

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ABSTRACT: This paper is based upon a study of 10,785 specimens of Gerrinae in the Francis Huntington Snow Collections of the University of Kansas. Keys to the genera of Gerrinae and Ptilomerinae and to the species of the Western Hemisphere are given. Besides many new records of distribution the following new forms are described: *Gerris ampla arizonensis* new var. from Arizona, U. S. A.; *Gerris fuscinervis invertis* new var. from Peru, S. A.; *Limnogonus visendus* Drake and Harris, winged form from Bazil, S. A.; *Limnogonus celeris magnus* new var. from Bolivia, Brazil, and British Guiana, S. A.; *Limnogonus aduncus uncatus* new var. from Peru, S. A.; *Tenagogonus spinulatus* sp. nov. from Peru, Bolivia, and Ecuador, S A.; *Tenagogonus duolineatus* sp. nov. from Bolivia, Paraguay, and Peru, S. A.; *Cylindrostethus palmaris* Drake and Harris, winged form from Bolivia, Brazil, and British Guiana, S. A.; and *Cylindrostethus bilobata* sp. nov. from Bolivia, S. A.

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* Submitted to the Department of Entomology and the Faculty of the Graduate School of the University of Kansas in partial fulfillment of the requirements for the degree of Master of Arts.

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INTRODUCTION

THE family Gerridae is universally distributed. It is divided into five subfamilies one of which is the subfamily Gerrinae which includes the largest of the American waterstriders. This paper includes a brief review of family and subfamily characters, a description of the Genera found in the Western Hemisphere, tables for the separation of species, and notes regarding the material in the University of Kansas Francis Huntington Snow Entomological collections. References are given to original descriptions and other important nomenclatorial descriptions relative to the genera and species.

In the genus *Gerris* there are representatives of all the species except *Gerris comatus mickeli* var., and *Gerris uhleri.* There are 4,913 specimens in the collection and two new varieties are herein recognized in the genus.

In the genus *Limnogonus* there are representatives of all the species except *Limnogonus genticus.* There are 3,655 specimens in the collection. The winged form of *Limnogonus visendus* is herewith described along with varieties of *Limnogonus celeris* and *Limnogonus aduncus.*

In the genus *Tenagogonus* there are representatives of all the known species and two species new to science are herein described. There are 461 specimens in the collection.

In the genus *Cylindrostethus* there are representatives of all the known species and the winged form, heretofore not known for this genus, along with a new species are herein described. There are 1,089 specimens in the collection.

In the genus *Potamobates* there are representatives of eight of the ten known species. There are 667 specimens in the collection.

ACKNOWLEDGMENT

The writer wishes to express his sincere appreciation for the helpful suggestions and kindly criticisms of Dr. H. B. Hungerford, of the University of Kansas, under whose direction this work was undertaken. Also to Dr. R. H. Beamer for his timely and helpful suggestions.

FAMILY GERRIDAE Amyot and Serville, 1843

Head horizontal, shorter than pro- and mesonota united, somewhat declivent in front of eyes. Antennae inserted in front of eyes, filiform, 4-segmented, the ringlike segment between two and three being considered as a part of the third. Rostrum short or long, 4-segmented. Body beneath densely clothed with short, appressed pile. Abdominal spiracles normal. Metasternal orifice (omphalium) median, often more or less prominent. Claws anteapical, inserted in a cleft a little before apex of last tarsal segment. Anterior legs comparatively short, raptorial, the femora more or less incrassate. Intermediate and hind legs very long, slender. Fore coxae considerably removed from middle pair, the middle and hind pairs placed close together.

KEY TO GROUPS OF GERRIDAE

The Gerrids are divided into five subfamilies which are separated into two groups as follows:

A. Inner margins of eyes sinuate or concave behind the middle. Body and abdomen comparatively long and narrow. Subfamilies Gerrinae and Ptilomerinae.

AA. Inner margins of eyes convexly rounded. Body and abdomen comparatively short and broad. Subfamilies Rhagadotarsinae, Haloveliinae, and Halobatinae.

KEY TO SEPARATE GERRINAE AND PTILOMERINAE

The subfamilies of Gerrinae and Ptilomerinae are separated as follows:

A. First segment of the antennae shorter than the other three conjoined; middle and hind femora not longer than the whole length of the body ..... *Gerrinae.*

AA. First segment of antennae not shorter than the other three conjoined. Middle and hind femora, or at least one of them, longer than the whole length of the body ..... *Ptilomerinae.*

SUBFAMILY GERRINAE Bianchi, 1896

Small or large, usually long, sides subparallel. General color brown to black, frequently marked with brilliant silvery pubescence. Thorax modified or changed according to degree of wing-development within a species (apterous, brachypterous, or macropterous). Abdomen composed of six visible segments (in reality seven as the first is not discernible beneath) and two genital segments. Pterygomorphism peculiar to many species. In alate forms hemelytra somewhat coriaceous, the nervures strongly developed and prominent. This subfamily is represented in the Western Hemisphere by five genera. *Potamobates* of Champion is the only genus restricted to the Americas.

KEY TO GENERA OF SUBFAMILY GERRINAE

1a. Antennae shorter than body 2a
1b. Antennae practically as long or longer than body 8a
2a. (1a) Body four times or more as long as broad 3a
2b. Body shorter, not four times as long as broad 4a
3a. (2a) Rostrum long, reaches middle of mesothorax ..... *Onychotrechus* Kirkaldy
3b. Rostrum short, not reaching base of prosternum ..... *Cylindrostethus* Fieber
4a. (2b) Basal tarsal subsegment of fore legs about half as long as second 5a
4b. Basal tarsal subsegment of fore legs subequal with second 7a
5a. (4a) Middle and hind legs short ..... *Rheumatotrechus* Kirkaldy
5b. Middle and hind legs very long, femora extending beyond apex of abdomen 6a
6a. (5b) Metasternum divided by a transverse suture; appears bisegmented. *Potamobates* Champion
6b. Metasternum entire ..... *Limnogonus* Stal
7a. (4b) Each tarsus terminated by two strong, curved, apical, aroliated claws. *Eotrechus* Kirkaldy
7b. Tarsus not so terminated with claws ..... *Gerris* Fabricius
8a. (1b) Fourth segment of antennae longest ..... *Tenagogonus* Champion
8b. First segment of antennae longest ..... *Potametropsis* Lundblad

KEY TO GENERA OF SUBFAMILY PTILOMERINAE

1a. First antennal segment shorter than the three following combined. Fore tibia without terminal spines ..... *Rheumatogonus* Kirkaldy
1b. First antennal segment much longer than the last three together. Fore tibia with terminal spines 2a
2a. Hind femur with spines, male larger than female, middle leg fringed with hairs. *Ptilomera* Amyot and Serville
2b. Hind femur without spines. Male smaller or size of female, middle leg not fringed with hairs 3a
3a. Body very short and broad, not longer than three times the breadth. *Potamometra* Bianchi
3b. Body elongate, longer than three times the breadth 4a
4a. First segment of anterior tarsi more than twice as long as second (including female Esakobates) ..... *Heterobates* Bianchi
4b. First segment of anterior tarsus not so long (except female Esakobates) 5a
5a. First anterior tarsal segment of male less than double the second, that of female two and one-half times as long as second ..... *Esakobates* Lundblad
5b. First anterior tarsal segment of both sexes less than twice as long as second 6a
6a. Connexivum of female drawn out into a long spinelike apophysis ... *Pleciobates* Esaki
6b. Connexivum of female wanting or when present not spinelike 7a
7a. Female much larger than male. Last abdominal segment of female not drawn out ..... *Rhyacobates* Esaki
7b. Both sexes of same size, last abdominal segment of female drawn out into two long, broad lobes ..... *Teratobates* Esaki

I. Genus GERRIS Fabricius, 1794

Logotype, *lacustris* (Linnaeus)

Gerris Fabricius, Ent. Syst., IV, 1794, p. 187; Latreille, Consid. Gen., 1810, pp. 259, 434 (names lacustris type); Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 144; Bergroth; Ent. Mo. Mag., (2) XIII, 1902, pp. 258-260; Distant, Fauna Brit. India, Rhyn., II, 1904, p. 176; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 208; Torre-Bueno, Trans. Amer. Ent. Soc., XXXVII, 1911, p. 244; Van Duzee, Cat. Hemip., 1917, p. 426; Hungerford, Bull. Univ. Kansas, XXI, 1919, p. 108.

Aquarius Schellenberg, Geschl. Land-und Wass. Wanz., 1800, p. 25.

Hydrometra Lamarck, Syst. Anim. s. Vert., 1801, p. 295 (in part); Fabricius, Syst. Rhyn., 1803, p. 256; Mayr, Reise Freg. Novara, Zool. II, Hemip., 1868, p. 169.

Hygrotrechus Stal, Ofv. Vet. Akad. Forh., XXV, 1868, p. 395; Uhler, Stand. Nat. Hist., II, 1884, p. 267.

Limnoporus Stal, Ofv. Vet. Akad. Forh., XXVII, 1868, pp. 395-396; Bergroth, Proc. U. S. Nat. Mus., LI, 1916, p. 237.

Limnotrechus Stal, Ofv. Vet. Akad. Forh., XXVII, 1868, p. 395.

Head short; eyes large, prominent, exserted. Antennae moderately slender, usually reaching hind margin of pronotum. Rostrum moderately short, reaching to or a little beyond the pro-mesosternal suture. Body subparallel, clothed with short, golden hairs.

In the apterous form the pronotum usually long, its hind lobe often covering a considerable part or even all of mesonotum, or sometimes short and not produced behind. Hemelytra, when present, dark, the nervures raised and prominent. Legs variable in length in different species, sometimes extremely long; middle and posterior femora and tibiae long; fore tarsal segments subequal in length. Body beneath covered with dense pile. Male genital segments symmetrical.

The genus *Gerris* is universally distributed, occurring on every continent. Thirty-two species and varieties are recognized from Continental and Insular America, two varieties of which are described below as new to science. Since *Gerris summatis* is known only from female specimens it is not included in the key. Pterygopolymorphism is common, many species being represented by macropterous, brachypterous, and apterous individuals. The nonshiny superior surface of head and thorax and the short golden pubescence upon upper surface of body and nervures of hemelytra serve to separate *Gerris* from *Limnogonus*.

KEY TO SPECIES OF GERRIS (MALES)

1a. Venter simply emarginate at apex. Connexival spines very long, reaching to or slightly beyond the middle of the last genital segment (except in chilensis Berg), 2a

1b. Venter doubly emarginate behind, the second emargination forming a more or less distinct notch at the middle. Connexival spines much shorter or wanting..... 8a

2a. Venter deeply, angularly, excavated behind, somewhat V-shaped. *uhleri* Drake & Harris

2b. Venter deeply rounded, emarginate behind, broadly U-shaped..... 3a

3a. Connexival spines very short, inconspicuous.....*chilensis* (Berg)

3b. Connexival spines quite long, prominent 4a
4a. First antennal segment subequal to or distinctly longer than II and III conjoined, color very dark 5a
4b. First antennal segment shorter than II and III conjoined. Body reddish brown or marked with reddish brown 6a
5a. First antennal segment longer than II and III conjoined. Last segment of venter without distinct median depression ..... *conformis* (Uhler)
5b. First antennal segment subequal to II and III conjoined. Last segment of venter with a promin nt, deep, broad, depressed median furrow ..... *nebularis* Drake & Harris
6a. Smaller, 8 to 11 mm. First genital segment with median keel at base. *caniculatus* Say
6b. Larger, 12 to 20 mm. First genital without median keel at base 7a
7a. Body long, with very long legs. Apex of first genital almost truncate. *notabilis* Drake & Harris
7b. Shorter, with shorter legs. Apex of first genital slightly roundly produced. *dissortis* Drake & Harris
8a. Connexiva not produced into distinct spines at apex. Segment I of antennae not or scarcely more than three-fifths as long as II and III conjoined. Anterior femora strongly curved 23a
8b. Connexiva distinctly produced at apex. Segment I of antennae as long as or almost as long as II and III conjoined. Fore femora not strongly curved 9a
9a. Large robust species (11 mm. or more). Connexival spines rather long and conical. First genital segment with very prominent, strongly elevated keel 10a
9b. Smaller species (less than 11 mm.). Connexival spines short, angular. First genital segment with keel only moderately prominent or absent 13a
10a. Larger, usually more or less brownish in coloration 11a
10b. Smaller, with shorter legs and antennae. Color deep black ..... *nyctalis* Drake & Harris
11a. Connexivum terminating in rather long pointed, sharp, spine. Hind margin of apical segment of venter not flared ..... *remigis* Say
11b. Connexivum terminating in very short and blunt spines. Hind margin of apical segment of venter flared 12a
12a. Hind margin of last ventral abdominal segment very prominently flared, making a deep transverse depression ..... *ampla* Drake & Harris
12b. Hind margin with a slight flare making a very shallow transverse depression. *ampla arizonensis* n. var.
13a. First genital segment beneath with conspicuous, long silvery hairs on each side 14a
13b. Genital segment without long hairs 15a
14a. Anterolateral margins of pronotum with a more or less distinct brownish line. First genital segment with hairs arranged in rows along each side of median ridge. *incognitus* Drake & Harris
14b. Pronotum without pale stripe along side margin in front. Hairs on first genital segment forming a distinct tuft ..... *comatus* Drake & Harris
15a. Anterolateral margins of pronotum with a silvery or rufous stripe 16a
15b. Anterolateral margins without pale stripe 16a
16a. Omphalium stongly produced, very prominent ..... *alacris* Hussey
16b. Omphalium not especially prominent 17a
17a. First genital segment plump, scarcely impressed on each side. *inseparatus* Drake & Harris
17b. First genital segment strongly impressed on each side 18a
18a. First tarsal segment shorter than second ..... *firma* Drake & Harris
18b. First tarsal segment subequal to second 19a
19a. Notch at hind margin of sixth venter broadly rounded ..... *incurvatus* Drake & Harris
19b. Notch at apex of sixth venter deeper, not so broadly rounded ..... *marginatus* Say
20a. First genital segment as broad as long, the notch in middle at apex of sixth venter, subrectangular ..... *buenoi* Kirkaldy
20b. First genital segment distinctly longer than broad, narrowed posteriorly, median apical notch of venter rounded 21a
21a. Anterolateral stripe of pronotum silvery ..... *argenticollis* Parshley
21b. Anterolateral stripe of pronotum flavous to brownish 22a
22a. Connexivum above with small silvery spots between the segments. *gillettei* Lethierry & Severin

22b. Connexivum without silvery spots.....*pingreensis* Drake & Harris
23a. Metasternum and venter with distinct or fairly distinct median carina. Pronotum extending on mesonotum in apterous form. First genital segment longer than broad 24a
23b. Metasternum and venter not carinate. Pronotum in apterous form not extending back over mesonotum. First genital segment short.....*flavolineatus* Champion
24a. Fore femora strongly curved from the base, suddenly dilated beneath into a tubercule-like prominence. Omphalium more or less prominent..... 25a
24b. Anterior femora much more flattened on basal half, without stout oblong prominence 28a
25a. First antennal segment in length distinctly greater than width of head through eyes. Protuberance of front femora near basal third.....*carmelus* Drake & Harris
25b. First antennal segment in length subequal to or less than width of head through eyes. Femoral protuberance at or beyond the middle..... 26a
26a. Fore femora with prominence at middle. Front lobe of pronotum in apterous form only moderately elevated 27a
26b. Fore femora with prominence at distal third. Anterior lobe of pronotum in apterous form strongly elevated.....*beieri* Drake & Harris
27a. Omphalium very strongly developed, forming an oblong prominence.
cariniventris Champion
27b. Omphalium not especially prominent.....*kahli* Drake & Harris
28a. Mesonotum in apterous form covered by pronotum.....*mexicanus* Champion
28b. Pronotum of apterous form not reaching to middle of mesonotum..... 29a
29a. Segments II, III, and IV of antennae subequal.....*fuscinervis* (Berg)
29b. Segment IV of antennae much shorter than either II or III.
fuscinervis invertis n. var.

1. *Gerris conformis* (Uhler)

Hygrotrechus conformis Uhler, Proc. Bost. Soc. Nat. Hist., XIX, 1878, p. 435.
Gerris conformis Drake and Harris, Ohio Journ. Sci., XXVIII, 1928, p. 271, fig. 1, g.
Gerris conformis (Uhler), Ann. Carn. Mus., Vol. XXIII, p. 185, 1934.

Sixteen apterous and macropterous specimens from the following states: Pennsylvania, Wisconsin, New York, South Carolina, and Ohio.

2. *Gerris nebularis* Drake and Hottes

Gerris nebularis Drake and Hottes, Proc. Biol. Soc. Wash., 28, 1925, p. 70; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 270, fig. 1, c.
Gerris nebularis Drake and Hottes, Ann. Carn. Mus., XXIII, 1934, p. 186, Pl. XXIII, fig. e.

Twenty-two apterous and macropterous specimens from the following states: Florida, Alabama, Kansas, Mississippi, Georgia, and North Carolina.

3. *Gerris uhleri* Drake and Hottes

Gerris uhleri Drake and Hottes, Proc. Biol. Soc. Wash., 38, 1925, p. 69; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 271, fig. 1, e; Drake and Harris, Ann. Carn. Mus., Vol. XXVIII, p. 186, Pl. XXIII, fig. g.

No representatives of this species.

4. *Gerris chilensis* (Berg)

Limnotrechus chilensis Berg, Ann. Soc. Cient. Argentina, XXII, 1881, p. 263.
Gerris chilensis Lethierry and Severin, Cat. Gen. Hemip., III, 1896, p. 60; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., 1908, p. 208; Drake and Harris, Ann. Carn. Mus., 1934, p. 187.

Fifty-five apterous specimens from Santiago de Chile, S. A., and Termes Caupuenes, Chile, S. A.

5. *Gerris canaliculatus* Say

Gerris canaliculatus Say, Heter. N. Harmony, 1832, p. 36; Torre-Bueno, Trans. Amer. Ent. Soc., XXXVII, 1911, p. 248; Drake and Harris, Ann. Carn. Mus., XXIII, 1934, p. 187, Pl. XXIV, fig. a.

Three hundred and twelve apterous and macropterous specimens from the following states: Florida, Georgia, Mississippi, Texas, Virginia, North Carolina, Alabama, Arkansas.

6. *Gerris dissortis* Drake and Harris

Gerris rufoscutellatus Riley, Ent. Rec. and Journ. Var., XXVII, 1925, pp. 65-72, 86-93, and 109-115.

Gerris dissortis Drake and Harris, Bull. Brook. Ent. Soc., XXV, 1930, p. 145.

One hundred and twenty-three macropterous specimens from the following states: New Hampshire, New York, New Jersey, Michigan, Wisconsin, North Dakota, Minnesota, and Russell, Manitoba.

7. *Gerris notabilis* Drake and Hottes

Gerris notabilis Drake and Hottes, Ohio Journ. Sci., XXV, 1925, p. 46; Drake and Harris, *ibid.*, XXVIII, 1928, p. 272, fig. 1, d; Drake and Harris, Ann. Carn. Mus., 1934, p. 189, Pl. XXIII, fig. d.

Eighteen winged paratypes and 168 other winged specimens. From the following states: South Dakota, Idaho, Washington, Oregon, Utah, Colorado, Arizona, and California.

8. *Gerris ampla* Drake and Harris

Gerris ampla Drake and Harris, Pan-Pacific Ento., 1938, Vol. XXIV, p. 73.

Thirty-eight apterous and macropterous specimens. All from the District of Temascaltepec, Real de Arriba, Mexico.

9. *Gerris ampla arizonensis* new var.

Length.—16 mm. to 17 mm. Antennal proportions of *Gerris ampla arizonensis*: Male, 135:67:62:70; female, 135:67:62:70. For *Gerris ampla*: Male, 158:82:74:75; female, 142:73:65:70.

Comparative notes.—In between *G. ampla* and *G. remigis* but closer to *G. ampla*. It differs from *G. remigis* in having shorter and stouter connexival spines, longer first antennal segment, much more prominently raised hind margin of last ventral abdominal segment of male; a lateral flavous line on pronotum, and a much broader and deeper emargination of last ventral abdominal segment of male. It differs from *G. ampla* by not having as distinctly raised hind margin of the last ventral abdominal segment, carina on first genital ventral

being not prominent to apex, the emargination of the last ventral abdominal segment is shallower and broader and the depression of last ventral abdominal is shallower.

Holotype, allotype, and thirty-three apterous and macropterous paratypes from the following localities: Huachuca Mt., Ariz.; Chiricahua Mts., Ariz.; and Santa Rita Mts., Ariz.

10. *Gerris remigis* Say

Gerris remigis Say, Heter. New Harmony, 1832, p. 35; Torre-Bueno, Ent. News, XXVIII, 1917, pp. 201-208; Riley, Ann. Ent. Soc. Amer., XIV, 1921, pp. 231-289; Essenberg, Journ. Animal Behavior, V, 1915, pp. 397-402; Drake and Harris, Ohio Journ. Sci., XXVIII, 1928, p. 269, fig. 1, a.

Gerris orba Stal, Freg. Eugen. Resa, Ins., 1859, p. 2641.

Hygrotrechus robusta Uhler, Am. Journ. Sci., Ser. 3, I, 1871, p. 105.

Gerris remigis Say, Drake and Harris, Ann. Carn. Mus., 1934, Vol. XXIII, p. 189, Pl. XXIII, fig. c.

Four hundred and twenty-nine apterous and macropterous specimens from following states: California, Washington, Arizona, Texas, Utah, New Mexico, Montana, Oklahoma, Indiana, Michigan, Pennsylvania, Maine, and Connecticut.

11. *Gerris nyctalis* Drake and Hottes

Gerris nyctalis Drake and Hottes, Ohio Journ. Sci., XXV, 1925, p. 47; Drake and Harris, *ibid.*, XXVIII, 1928, p. 269, fig. 1, b; Drake and Harris, Ann. Carn. Mus., 1934, Vol. XXIII, p. 190, Pl. XXIII, fig. b.

Eleven apterous and macropterous specimens from Tooele county, Utah; Estes Park, Colo.; Paradise, Utah; Sherborn, Mass.; and S. Saskatchewan, Canada.

12. *Gerris inseperatus* Drake and Hottes

Gerris inseperatus Drake and Hottes, Proc. Biol. Soc. Wash., 38, 1925, p. 71; Blatchley, Heter. E. North Amer., 1925; Drake and Harris, Ohio Journ. Sci., XXVIII, 1928, p. 270; Drake and Harris, Ann. Carn. Mus., 1934, Vol. XXIII, p. 190, Pl. XXII, fig. b.

Forty-five macropterous specimens from following localities: Fairmont, West Virginia; Warrenton, Virginia; Ithaca, New York; Beaufort, North Carolina; Smithville, Mississippi; Arendtsville, Pennsylvania; Cochise county, Arizona; and Aguascalientes, Mexico.

13. *Gerris marginatus* Say

Gerris marginatus Say, Heter. N. Harmony, 1832, p. 36; Drake and Harris, Ohio Journ. Sci. XXVIII, 1928, p. 271; Drake and Harris, Ann. Carn. Mus., 1934, Vol. XXIII, p. 191, Pl. XXII, fig. f.

One hundred and sixty-six apterous and macropterous specimens from following states: Texas, California, Wyoming, North Carolina, Oregon, Alabama, Minnesota, New Mexico, Kansas and Arkansas.

14. *Gerris incurvatus* Drake and Hottes

Gerris incurvatus Drake and Hottes, Proc. Biol. Soc. Wash., 38, 1925, p. 72; Drake and Harris, Ohio Journ. Sci., XXVIII, 1928, p. 270; Drake and Harris, Ann. Carn. Mus., XXIII, 1934, p. 192, Pl. XXII, fig. j.

Two hundred and three apterous, brachypterous, and macropterous specimens from following states: California, Washington, Idaho, Wyoming, Montana, Oregon, Texas, and from Oliver, Brit. Columbia.

15. *Gerris alacris* Hussey

Gerris alacris Hussey, Psyche, XXVIII, 1921, pl. II, fig. 1; Blatchley, Heter. E. N. America, 1925, p. 975; Drake and Harris, Ohio Journ. Sci., XXVIII, 1928, p. 272; Drake and Harris, Ann. Carn. Mus. XXIII, 1934, p. 192, pl. XXII, fig. 1.

One male paratype and 6 other macropterous specimens. The paratype from Berrien county, Michigan. Others from Cherokee county, Kansas; Ft. Lee Dist., New Jersey; Lakehurst, New Jersey; Raleigh, North Carolina; and Freyburg, Maine. Heretofore not known from Maine, Kansas, and North Carolina.

16. *Gerris comatus* Drake and Hottes

Gerris comatus Drake and Hottes, Ohio Journ. Sci., XXV, 1925, p. 48; Drake and Harris, *ibid.*, XXVIII, 1928, p. 270; Drake and Harris, Ann. Carn. Mus., XXIII, 1934, p. 193, Pl. XXII, figs. *c* and *d*.

Two paratypes and 156 other macropterous specimens. Paratypes from Ames, Iowa. Others from following states: New York, New Mexico, Minnesota, Michigan, South Dakota, Arizona, New Hampshire, Connecticut, Florida, Colorado, Indiana, Kansas, and from Mafeking, Manitoba.

17. *Gerris comatus mickeli* Drake and Hottes

Gerris comatus Drake and Hottes, Ohio Journ. Sci., XXV, 1925, p. 48; Drake and Harris, *ibid.*, XXVIII, 1928, p. 270; Drake and Harris, Ann. Carn. Mus. XXIII, p. 193.

No representatives.

18. *Gerris incognitus* Drake and Hottes

Gerris incognitus Drake and Hottes, Proc. Biol. Soc. Wash., 38, 1925, p. 73; Drake and Harris, Ohio Journ. Sci., XXVIII, 1928, p. 270; Drake and Harris, Ann. Carn. Mus. XXIII, p. 193, Pl. XXII, fig. a.

Two hundred and fifty-five apterous and macropterous specimens from following states: Washington, Idaho, Oregon, Montana, California, Colorado, and Wyoming.

19. *Gerris pingreensis* Drake and Hottes

Gerris pingreensis Drake and Hottes, Ohio Journ. Sci., XXV, 1925, p. 49; Drake and Harris, *ibid.*, XXVII, 1928, p. 272; Drake and Harris, Ann. Carn. Mus. XXIII, 1934, p. 194.

Four hundred and thirty-seven paramorphotypes from Pingree Park, Colorado; 488 other apterous and macropterous specimens from Pingree Park and Estes Park, Colorado.

20. *Gerris gillettei* Lethierry and Severin

Limnotrechus productus Uhler, Hemip. Colo., 1895, p. 61.

Gerris gillettei Lethierry and Severin, Cat. Genl. Hemip., III, 1896, p. 60; Drake and Harris, Ohio Journ. Sci., XXVIII, 1928, p. 272; Drake and Harris, Ann. Carn. Mus., XXIII, 1934, p. 194, Pl. XXII, figs. g and h.

Holomorphotype, allomorphotype, 8 paramorphotypes and 184 other apterous and macropterous specimens. Types from Emery county, Utah. Others from Wyoming.

21. *Gerris buenoi* Kirkaldy

Gerris buenoi Kirkaldy, Ent. News, XXII, 1911, p. 246; Torre-Bueno, Trans. Amer. Ent. Soc., XXXVII, 1911, p. 248; Parshley, Ent. News, XXVII, 1916, pp. 103-104, fig. c; Hoffman, Ann. Ent. Soc. Amer., XVII, 1924, pp. 424-426; Drake and Harris, Ann. Carn. Mus., XXIII, 1934, p. 195, Pl. XXII, fig. e; Drake and Harris, Ohio Journ. Sci., XXVIII, 1928, p. 272.

Four hundred and seventy-three apterous and macropterous specimens from following: Burley, Idaho; Cheboygan county, Mich.; Freyburg, Maine; Three Forks, Montana; Rochester, Washington; Trout Lake, Michigan; and from Oliver, Brit. Columbia.

22. *Gerris argenticollis* Parshley

Gerris argenticollis Parshley, Ent. News, XXVII, 1916, p. 103, fig. *a;* Drake and Harris, Ohio Journ. Sci., XXVIII, 1928, p. 272; Drake and Harris, Ann. Carn. Mus., XXIII, p. 196, Pl. XXII, fig. *k*.

Six macropterous specimens from Forest Hills, Massachusetts; Ithaca, New York; Berrien county, Michigan; and Koscinsko county, Indiana.

23. *Gerris mexicanus* Champion

Gerris mexicanus Champion, Biol. Centr. Amer., Rhynch., II, 1898, p. 147, Pl. IX, fig. 10; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 209; Drake and Harris, Ann. Carn. Mus., XXIII, 1934, p. 196.

Eleven apterous and macropterous specimens from Michoacan, Tancitaro, Mexico. Altitude 6,586 feet.

24. *Gerris flavolineatus* Champion

Gerris flavolineatus Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 149, Pl. IX, figs. 13-15; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 209; Drake and Harris, Ann. Carn. Mus., XXIII, 1934, p. 197, Pl. XXIV, fig. *c*.

One hundred and nineteen apterous and macropterous specimens from San Antonio, Mexico; Real de Arriba, District of Temascaltepec, Mexico; Rio Grande, Mexico; and from Guatemala.

25. *Gerris cariniventris* Champion

Gerris cariniventris Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 148, Pl. IX, figs. 11-12; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 208; Drake and Harris, Ann. Carn. Mus., XXIII, 1934, p. 197, Pl. XXIV, fig. *b*.

Seven hundred and fifty-one apterous and four macropterous specimens from Rio Blanco, Ecuador, S. A.; Dept. Cajamarco, Peru,

S. A.; and State of Oaxaca, Mexico. The first two localities are new to science.

26. *Gerris fuscinervis* (Berg)

Brachymetra fuscinervis Berg, Com. Mus. Buenos Aires, 1, 1898, p. 3; Pennington, List Hemiptera-Heteroptera, Repub. Argentina, 1921, p. 31.

Gerris perseus Kirkaldy, Bull. Mus. Zool. Anat. Comp. Torino, XIV, 1899, No. 351 p. I.

Gerris andromeda Kirkaldy, Bull. Mus. Zool. Anat. Comp. Torino, XIV, 1899, No. 351, p. 2, figs. 8, 9.

Gerris fuscinervis Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 208; Drake and Harris, Ann. Carn. Mus. XXIII, 1934, p. 198.

Six hundred and sixty-three apterous and 12 macropterous specimens from Cochabamba, Bolivia, S. A. and La Granja Alta gracia Cordoba, Argentina, S. A.

27. *Gerris fuscinervis invertis* new var.

The carina on the metasternum indistinct but otherwise running down to *G. fuscinervis* in the Drake and Harris key. It differs from *G. fuscinervis* by the last antennal segment being the shortest (proportions: Male, 62:51:55:48; female, 91:72:67:60), the emargination of the last ventral abdominal segment not being as deeply notched, the anterior lobe of the pronotum being more distinctly elevated and the posterior lobe more angular and slightly narrower. The colors vary from a bright rufous to a dark brown.

There are 164 apterous specimens from Vic. Pampa Hermosa, Peru, S. A.; Vic. San Pedro, Peru, S. A.; and near Viena Andes (semitropical, 2,600 meters above sea), Peru, S. A.

28. *Gerris kahli* Drake and Harris

Gerris kahli Drake and Harris, Ann. Carn. Mus. XXIII, 1934, p. 199.

Fifty-eight apterous and macropterous specimens from Ecuador, S. A.

29. *Gerris beieri* Drake and Harris

Gerris beieri Drake and Harris, Ann. Carn. Mus., XXIII, 1934, p. 200.

Eight macropterous specimens from Kenskoff, Haiti, and Real de Arriba, Mexico.

30. *Gerris carmelus* Drake and Harris

Gerris carmelus Drake and Harris, Psyche, XXXIV, 1933, p. 108; Drake and Harris, Ann. Carn. Mus., XXIII, 1934, p. 201, Pl. XXV, fig. *d*.

One paratype and 12 other apterous and macropterous specimens. Paratype from Jamaica, near Troy; others from Buff Bay River, Jamaica.

31. *Gerris summatis* Drake and Harris

Gerris summatis Drake and Harris, Ann. Carn. Mus. XXIII, 1934, p. 201.

Holotype and one paratype (macropterous female) from Rio Surapiqui, Costa Rica.

II. Genus LIMNOGONUS Stal, 1868

Logotype, *hyalinus* Fabricius

Limnogonus Stal, Hemip. Fabr., I, 1868, p. 132; Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 151; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 210.

Lamprotrechus Reuter, Ofv. Finska Vet. Soc. Fork., XXV, 1882, p. 40.

Tenagogonus Van Duzee, Cat. Hemip., 1917, p. 429 (in part); Anderson, University of Kansas, Sci. Bull., XX, 1932, p. 298.

Body short to moderately elongate, the abdomen somewhat abbreviated in certain species, long in others; head and pronotum glabrous, shiny. Antennae shorter than body, the basal segment longest. Anterior tarsi with first segment short, only about half as long as second. Middle and hind legs very long, the femora extending far beyond the tip of abdomen.

The short basal tarsal segment of fore legs, shorter and stouter antennae, and the shiny surface of the head and pronotum are the chief characters separating *Limnogonus* from *Tenagogonus* and *Gerris*.

Thirteen species have been recognized and two new varieties are herein described. The winged form of *Limnogonus visendus* heretofore not known is described along with a variety of *L. aduncus* and *L. celeris*.

It should be noted that in some species female specimens are as yet unknown. Also in certain species both alate and apterous forms have not been described for both sexes. As a consequence of the great structural differences between these forms within a species, it has been impossible to construct a complete key. The table given below, however, will serve to identify all the forms now known.

KEY TO SPECIES OF LIMNOGONUS

1a. Pale markings on margins of pronotum continued anteriorly along the sides of the front lobe and extending to its front margin. (If interrupted or obsolete along side margins of front lobe then the length of antennal I is greater than width of head through eyes.) 11a

1b. Side margins of anterior lobe of pronotum without evidence of pale lines. Length of antennal I usually less than width of head through eyes, sometimes subequal.. 2a

2a. Apterous 3a

2b. Macropterous (*celeris* and *genticus* unknown in winged form) 8a

3a. Pronotum produced posteriorly, distinctly longer than broad, differentiated into two lobes 5a

3b. Pronotum short, broader than long, without evidence of hind lobe 4a

4a. Length of first antennal segment subequal to width of head through eyes. Apex of abdomen not surpassing basal one-fifth of hind femora ..... *hesione* (Kirkaldy)

4b. Length of first antennal scarcely greater than width of vertex plus one eye. Abdomen much longer, extending to basal one-third of hind femora.
visendus Drake & Harris

5a. Pronotum reaching to metanotum, almost or completely covering mesonotum.... 6a

5b. Pronotum reaching to middle of mesonotum.... 7a

6a. First genital segment above narrow, tapering posteriorly, the apical margin not or scarcely notched at middle.... *lubricus* White

6b. First genital segment above very broad, the sides almost parallel, the hind margin deeply notched at middle.... *celeris* Drake & Harris

7a. Larger. Male, 5.6 mm.; female, 6.7 mm. Eyes as seen from the side almost spherical, not longer than deep.... *lotus* White

7b. Smaller. Male, 4.15 mm. Eyes as seen from the side flattened, plainly longer than deep.... *genticus* Drake & Harris

8a. Eyes globose, not longer than deep. Pronotum strongly constricted at the sides between the two lobes. Front femora with an oval blackish spot on the outer (posterior) surface before apical third.... *lotus* White

8b. Eyes longer than deep. Pronotum less strongly constricted at the sides. Front femora almost entirely blackish along distal half of posterior surface.... 9a

9a. Antennal segments I and II, except apices, brownish.... 10a

9b. Antennal segments I and II entirely fuscous to black.... *hesione* (Kirkaldy)

10a. Second genital segment with a distinct tuft of pale hairs on each side.
visendus Drake & Harris

10b. Second genital segment of male without tuft of pale hairs on each side.
lubricus White

11a. Antennal segment I less than width of head through eyes. Mesopleura broadly marked with reddish or russet brown along the upper sides... *ignotus* Drake & Harris

11b. Antennal segment I equal to or greater than width of head through eyes. Mesopleura above next to pronotal margins brown to black, sometimes interrupted with yellowish or silvery.... 12a

12a. Male.... 13a

12b. Female.... 18a

13a. First genital segment beneath produced at apex.... 15a

13b. First genital segment beneath not produced at apex.... 14a

14a. Metasternum distinctly swollen. First genital segment slightly impressed on each side.... *guerini* (Lethierry & Severin)

14b. Metasternum flat, not swollen; first genital segment beneath distinctly constricted across the middle, broader than distance between apices of connexiva.
profugus Drake & Harris

15a. First genital segment beneath with a tumid, almost hemispherical gibbosity, the apex produced at the middle into a prominent recurved spine.... *recurvus* Drake & Harris

15b. First genital segment not as above.... 16a

16a. First genital segment beneath raised into an enormous keel, this greatly produced so that it extends as far posteriorly as does the dorsal part of the segment.
hyalinus (Fabricius)

16b. First genital segment not as above.... 17a

17a. Apex of first genital segment beneath produced at the middle into a short oblique point. Mesosternum plump.... *recens* Drake & Harris

17b. Apex of first genital segment beneath produced into a short, recurved tooth. Mesosternum broadly, shallowly impressed.... *aduncus* Drake & Harris

18a. Connexivum truncate at apex, not produced beyond corresponding abdominal tergite.
hyalinus (Fabricius)

18b. Connexivum more or less produced at apex, extending beyond last abdominal tergite.... 19a

19a. Last segment of venter rather sharply produced at the middle behind. Connexival spines moderately long.... *aduncus* Drake & Harris

19b. Last segment of venter more broadly rounded behind. Connexivum not so strongly produced apically.... 20a

20a. Upper portion of mesopleura largely reddish-brown, this not divided by a paler longitudinal stripe.... *recurvus* Drake & Harris

20b. Upper portion of mesopleura black, this divided by a more or less broad yellowish to silver stripe.... 21a

21a. Last venter more strongly produced, the central portion extending slightly farther posteriorly than the connexival processes. The yellowish-brown stripe of mesopleura expanded, arched above broader than the black.....*profugus* Drake & Harris

21b. Last segment of venter only slightly produced behind. Yellowish-brown stripe of mesopleura narrower, its sides practically parallel..... 22a

22a. Connexivum above with a broad, uninterrupted longitudinal yellowish-brown stripe. *guerini* (Lethierry & Severin)

22b. Connexivum above with three to five large silvery to yellowish-brown spots, these sometimes more or less connected.....*recens* Drake & Harris

1. *Limnogonus hesione* (Kirkaldy)

Gerris hesione Kirkaldy, Entomologist, XXXV, 1902, p. 137.

Tenagogonus hesione Barber, Bull. Am. Mus. Nat. Hist., XXXIII, 1914, p. 499; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 273.

Limnogonus hesione Osborn and Drake, Ohio Nat., XV, 1915, p. 503, fig. 1; Blatchley, Heteroptera E. N. Amer., 1928, p. 179, fig. 194.

Four hundred and twenty-two apterous and macropterous specimens. The specimens were taken from the following states and areas: Missouri, North Carolina, Alabama, Oklahoma, Kansas, Florida, Mississippi, Louisiana, and from Catalina, Cuba.

2. *Limnogonus visendus* Drake and Harris

Limnogonus visendus Drake and Harris, 1934. Ann. Carn. Mus., XXIII, p. 215.

Three hundred and fifty-nine apterous and 44 macropterous specimens. The macropterous form is new to science and is here described for the first time. The apterous specimens bear the following area labels: Rio Purus, Castanha Region, Brazil, S. A.; Vic. Santo Antonio R., Brazil, S. A.; Vic. Joao Pessoa, R. Jurua, Brazil, S. A.

DESCRIPTION OF WINGED FORM

Size.—Length of males, 5.5 to 7 mm.; width, 1.7 to 2.3 mm.; length of females, 6 to 8 mm.; width, 2 to 2.8 mm.

Color.—Grayish-black. Head black with a broad yokelike mark above ochraceous to fulvous. Anterior lobe of pronotum moderately prominent, disc depressed with a median round fulvous spot. Prominent constriction between anterior and posterior lobes, posterior lobe extending on metanotum, indistinctly carinate, margined with fulvous to ochraceous line. Humeri moderately prominent, a slight transverse elevation between them. Hemelytra brownish, the nervures darker and prominent. The posterior lobe of pronotum punctate and covered with fine hair.

Holomorphotype, allomorphotype and 42 paramorphotypes in the Francis Huntington Snow Entomological Collections. These were taken from the following locations: Santo Antonio river, Brazil, S. A.; and Sao Phelipe river, Brazil, S. A.

3. *Limnogonus lubricus* White

Limnogonus lubricus White, Jour. Linn. Soc. Lond., Zoöl., XIV, 1879, p. 489; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 210.

Two hundred and eighty-eight apterous and macropterous specimens. Specimens from the following places: Santa Rosa del Yacuma, Bolivia, S. A.; State of Para, Lago Grande, Plantation Ogle, B. Guiana; Vic. Sani Beni, Peru, S. A.; R. Madeira, Porto Velho, Brazil, S. A.

4. *Limnogonus celeris* Drake and Harris

Limnogonus celeris Drake and Harris, Ann. Carn. Mus., XXIII, pp. 214-215, Pl. 25, fig. a.

Holotype, allotype, and one paratype. These were taken from locality of Villarrica, Paraguay, S. A.

5. *Limnogonus celeris magnus* new var.

Length, 8 mm.; width, 2.5 to 3.5 mm.

This form runs to *L. celeris*, using the length of the first antennal segment being shorter to subequal to the width of head through the eyes. Pale markings on margins of pronotum continued anteriorly along sides of front lobe on some specimens; obsolete on others. Macropterous forms are not included in key as *L. celeris* winged form is unknown. Distal half of front femora almost entirely blackish; antennal segments I and II brownish.

This variety differs from *L. celeris* by its larger size and antennal proportions. Proportions: apterous male: 88:56:42:47, macropterous specimens, 94:58:44:53. Posterior lobe of pronotum does not touch metanotum, but greatly exceeds the middle of mesonotum. The hind margin of first genital above not as deeply notched and penultimate segment of rostrum is dark brown. No apterous female specimens.

DESCRIPTION OF WINGED FORM

Pronotum black. Posterior lobe subangular reaching metanotum, margined with ochraceous, indistinctly carinated, widest across humeri. Humeri prominent. Anterior lobe medianly depressed, flavous spot in center. Hemelytra light brown, nervures darker. Hemelytra surpassing last genital segment.

Holotype, allotype and 46 macropterous paratypes. Holotype and allotype from R. Beni Cachuela, Esperanza, Bolivia, S. A.; Paratypes from R. Beni Cachuela, Esperanza, Bolivia, S. A.; Vic. Santo Antonio R., Brazil, S. A.; and Supuruni Creek, Brit. Guiana.

6. *Limnogonus lotus* White

Limnogonus lotus White, Jour. Linn. Soc. Lond., Zoöl., XIV, 1879, p. 488; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 210; Drake and Harris, Ann. Carn. Mus., XIX, 1930, p. 236.

One thousand and thirty-one apterous and macropterous specimens. These bear the following labels: Vic. Joao Pessoa, (Sao Phelipe) River, Jurua, Brazil, S. A.; Vic. Santo Antonio River, Brazil, S. A.; Supuruni Creek, British Guiana, S. A.; Rio Negro, Manaos Region, Brazil, S. A.; Porto America, Brazil, S. A.; R. Amazonas, Region de Itacoatiara, Brazil, S. A.; Dept. Huanuco, Vic. Leonpampa Jungle, Peru, S. A.; near New Amsterdam, Brit. Guiana, S. A.

7. *Limnogonus ignotus* Drake and Harris

Limnogonus ignotus Drake and Harris, Ann. Carn. Mus., Vol. 23, p. 205.

Holotype, allotype, 18 paratypes, and 76 other specimens. The types are from Villarrica, Paraguay, S. A.; Santa Cruz, Bolivia, S. A.; near New Amsterdam, Brit. Guiana, S. A. The other specimens are from the same localities and also the following: Vic. Rioja, Dept. San Martin, Peru. S. A.; Santa Ana del Yacuma, Bolivia, S. A.; Georgetown, Brit. Guiana, S. A.; E. Coast Demerara, Brit. Guiana, S. A.

8. *Limnogonus guerini* (Lethierry & Severin)

Gerris marginatus Guerin, Icon. Regne Anim., Ins., 1844, p. 351, Pl. 57, fig. 2; Guerin, in Ramon de la Sagra's Hist. fis., polit. y nat. de Cuba, Ins., 1857, p. 415.

Limnometra marginata Uhler, Proc. Zoöl. Soc. Lond., 1893, p. 706, 1894, p. 212.

Gerris guerini, Lethierry and Severin, Cat. Gen. Hemip., III, 1896, p. 61.

Limnogonus marginatus Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 152.

Limnogonus guerini Kirkaldy & Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 210; Drake and Harris, Psyche, XXXIX, 1933, p. 109.

Three hundred and fourteen apterous and macropterous specimens. These with the following labels: Havana, Cuba; Gonaives, Haiti; Punta Gorda, Brit. Honduras; Jamaica, B. W. I.; La Libertad, Chiapas, Mex.; Vic. Pacasmayo, Peru, S. A.; St. Thomas, Virgin Islands; Costa Rica, C. A.; Caba Rojo, P. Rico; Lesser Antilles; and Dept. Cajamarco, Peru, S. A.

9. *Limnogonus profugus* Drake and Harris

Limnogonus profugus Drake and Harris, Ann. Carn. Museum, XIX, 1930, p. 237; Ann. Carn. Museum, Vol. XXIII, 1934, p. 209.

Thirty-three apterous specimens from Rezenda Estado de Rio, Brazil, S. A.; Campinas Estado de Sao Paulo, Brazil, S. A.; Itaquaquecetuba, Brazil, S. A.

10. *Limnogonus genticus* Drake and Harris

Limnogonus genticus Drake and Harris, Ann. Carn. Museum, Vol. XXIII, p. 213.

No representatives.

11. *Limnogonus recurvus* Drake and Harris

Limnogonus recurvus Drake and Harris, Ann. Carn. Mus., XIX, 1930, p. 236; Ann. Carn. Museum, Vol. XXIII, pp. 210-211, Pl. 24, figs. j and k.

One hundred and eighty-three apterous and macropterous specimens. The specimens are from the following places: Santa Cruz, Bolivia, S. A.; Santa Rosa del Yacuma, Bolivia, S. A.; State of Para, Lago Grande, Brazil, S. A.; R. Madeira, Porto Velho, Brazil, S. A.

12. *Limnogonus hyalinus* (Fabricius)

Hydrometra hyalinus Fabricius, Syst. Rhyng., 1803, p. 258.

Limnogonus hyalinus Stal, Hemip. Fabr., I, 1868, p. 133; Ann. Carn. Museum, Vol. XXIII, p. 208, Pl. 25, fig. b.

Eighty apterous and macropterous specimens. From the following localities: Supuruni Creek, Brit. Guiana, S. A.; E. Coast Demerara, Brit. Guiana, S. A.; Trinidad, B. W. I.

13. *Limnogonus recens* Drake and Harris

Limnogonus hyalinus Champion, Biol. Centr.-Amer., Rhyn. II, 1898, p. 153, Pl. IX, fig. 18; Torre-Bueno, Trans. Am. Ent. Soc., XXVII, 1911, p. 245.

Tenagogonus hyalinus Drake and Harris, Ohio Jour. Sci., 1928, XXV, p. 273.

Limnogonus recens Drake and Harris, Ann. Carn. Museum, Vol. XXIII, p. 207, Pl. XXV, fig. c.

One paratype and 23 other apterous and macropterous specimens. The paratype from Punta Gorda, Honduras, B. W. I.; others from San Isidro, Costa Rica, C. A.; Talcha, Yucatan, Mex.; Chiapas, La Libertad, Mex.; Palpite Cienaga de Zapute, S. C. Prov. Cuba; Los Amates, Guatamela.

14. *Limnogonus aduncus* Drake and Harris

Limnogonus aduncus Drake and Harris, Psyche, XXXIX, 1933, p. 110.

Limnogonus aduncus Drake and Harris, 1934, Ann. Carn. Mus., Vol. XXXII, pp. 209-210, Pl. 24, fig. 1.

Seven hundred and twenty apterous and macropterous specimens. Specimens from following places: Manaos Region Rio Negro, Bazil, S. A.; Trinidad, B. W. I.; Ft. Clayton, C. Z.; Georgetown, Brit. Guiana, S. A.; Santo Rosa del Yacuma, Bolivia, S. A.; State of Para, Brazil, S. A.; Castanha Region Rio Purus, Brazil, S. A.; Vic. Sani Beni, Peru, S. A.; Dept. Amazonas, Peru, S. A.; Santa Cruz, Bolivia, S. A.; Vic. of San Pedro, Peru, S. A.; Dept. San Martin, Peru, S. A.

15. *Limnogonus aduncus uncatus* n. var.

Differs from *L. aduncus* in having a much longer and more prominently recurved or hooklike projection on ventral side of first genital segment. Last ventral abdominal is greater than the preceding two segments (less in *L. aduncus*) and a more prominently elevated anterior lobe of pronotum.

Holotype, allotype, and 43 paratypes. From Vic. of San Pedro, Peru, S. A.; Vic. Rio Negro, 790 m. a. s. l. in R. Negro, Peru, S. A.; Vic. Pampa Hermosa, 16 m. a. s. l., Peru, S. A.; and Sani Beni, 840 m. a. s. l., Peru, S. A.

III. Genus TENAGOGONUS Stal, 1855

Haplotype, *albovittatus* Stal

Tenagogonus Stal, Ofv. Vet.-Akad. Forh., X, 1853, p. 263 (*nomen nudum*); Stal, *ibid.*, XII, 1855, p. 45; Stal, Hemip. Afr., III, 1865, p. 168; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 209; Bergroth, Zool. Med. Rijks. Mus. Nat. Hist., I, 1915, p. 123.
Limnometra Mayr, Verh. Zool. Bot. Ges. Wien., XV, 1865, p. 443; Freg. Novara, Zool., II, 1868, p. 175; Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 150.

Moderately elongate, dull, finely pubescent. Antennae long, slender, about as long as or slightly longer than the entire body; segments I and II moderately stout, III and IV filiform, IV longest. Eyes exserted. Rostrum long. Anterior tarsal segments subequal in length. Intermediate and posterior legs very long, their femora extending far beyond the apex of abdomen.

Two new species referable to this genus are herein described making the total number of water striders occurring in the Western Hemisphere of this genus 5. In all, the middle and posterior acetabula as seen from above are marked with conspicuous, silvery sericeous spots. Only winged forms are known for the described American species; however, Champion recorded one wingless specimen (species uncertain) from Central America.

KEY TO SPECIES OF TENAGOGONUS

1a. Male 2a
Female 6a
2a. With black markings on head and thorax 5a
Without black markings on head and thorax 3a
3a. With prominent tubercle on inner side of basal half of fore femora (fig. 2a). *celocis* Drake & Harris
3b. Without tubercle on fore femora 4a
4a. Dorsal margin of ventral plate of second genital with a median toothlike projection (fig. 3a) ..... *spinulatus* sp. nov.
4b. Dorsal margin of ventral plate of second genital without a projection (fig. 1a). *opacus* (Champion)
5a. Posterior lobe of pronotum predominately ochraceous (fig. 4a)... *duolineatus* sp. nov.
5b. Posterior lobe of pronotum predominately black (fig. 5a).. *quadrilineatus* (Champion)

6a. Without black markings on head and thorax..... 7a
6b. With black markings on head and thorax..... 9a
7a. Venter of sixth abdominal segment, strongly, subquadrately produced at middle behind (fig. 2) .....*celocis* Drake & Harris
7b. Venter of sixth abdominal segment not subquadrately produced posteriorly..... 8a
8a. Venter of sixth abdominal segment broadly produced a long distance beyond short connexival spines (fig. 3).....*spinulatus* sp. nov.
8b. Venter narrowly, triangularly produced, spines longer ending at posterior margin of sixth venter (fig. 1).....*opacus* (Champion)
9a. Connexival spines long, extending over half their length beyond posterior margin of sixth venter (fig. 4).....*duolineatus* sp. nov.
9b. Connexival spines short, not exceeding posterior margin of sixth venter (fig. 5). *quadrilineatus* (Champion)

1. *Tenagogonus celocis* Drake and Harris

(Plate X, figs. 2, 2a)

Tenagogonus opacus Drake and Harris, Ann. Carn. Mus., XIX, 1930, p. 235.
Tenagogonus celocis Drake and Harris, *ibid.* XX, 1931, p. 267.

Macropterous and brachypterous specimens. Ninety-one specimens from following places: Dept. Huanuco, vic. of Afilador, Peru, S. A.; R. Beni Cachuela, Esperanza, Bolivia, S. A. Heretofore not known from Bolivia.

2. *Tenagogonus spinulatus* sp. nov.

(Plate X, figs. 3, 3a)

Size.—Male, 8 to 11.7 mm. length; 2.3 to 2.9 mm. width. Female, 10.5 to 12.3 mm. length; 2.8 to 3.3 mm. width.

Color.—Brownish ferruginous above, pale ochraceous beneath. Head ferruginous, base of antennae dark brown, first two segments light brown, III and IV dark brown. Pronotum ferruginous, median ochraceous line on anterior lobe extending on anterior portion of posterior lobe, anterolateral margins with a pale testaceous stripe which continues on mesopleura to mesoacetabula. Posterior portion of posterior lobe darker, the submarginal groove filled with golden pubescence. Costal margin lighter. Rostrum ochraceous, apical segment black. Meso- and meta-acetabula with silvery spots. Brownish area on both sides of testaceous line.

Structural characteristics.—Antennal proportions: Male, 78:60: 97:131; female, 78:57:98:134. Pronotum (anterior lobe) slightly depressed, moderately constricted between anterior and posterior lobe. Posterior lobe of pronotum extending on metathorax. Humeri moderately prominent. Rostrum almost reaching to middle of mesosternum. Mesosternum with narrow and moderately deep channel. Metasternum with broad and prominent carina. Fore femora with basal portion ochraceous, slightly curved, distal three-fourths darker. Tibia brown, distal (female) portion slightly enlarged gives a curved appearance to tibia. In the male, the last abdominal venter broadly,

roundly emarginate. First genital segment faintly transversely impressed about middle; dorsal posterior margin slightly concave. Ventral plate of second genital segment with a median pair of small dorsally projecting spinoid processes. Dorsal plate conical. Both genital segments hairy. Connexiva not produced; moderately broad. Last ventral abdominal shorter than preceding two segments. Female: connexiva very short, triangular. Sixth ventral abdominal segment produced a great distance beyond spines, the plate with posterior margin truncate. Dorsolateral margin of second ventral genital produced as toothlike projection near middle. See plate.

Comparative notes.—Very close to *Tenagogonus opacus*, but the male differs in having a spinoid process on dorsal margin of second genital ventral plate on either side. This varies in size in some specimens. The female has much shorter spines and the sixth ventral abdominal plate has a much broader projection which extends far beyond the connexival spines. There is much variation in color in this species; specimens from Bolivia being much lighter and without distinct lines.

Types.—Holotype, allotype, and 43 paratypes. Sixteen other specimens. All macropterous specimens. Types from Vic. Rioja, Dept. San Martin, Peru, S. A.; vic. Rio Negro, 790 mi. a. s. l. in R. Negro, Peru, S. A. Others with following labels: Road between Todos Santos and Palmer, R. Chapare, Bolivia, S. A.; Ecuador, S. A., Feb. 11, 23.

3. *Tenagogonus opacus* (Champion)

(Plate X, figs. 1, 1a)

Limnometra opaca Champion, Biol. Centr.-Amer., Rhynch., II, p. 150, Pl. IX, 1898, figs. 16, 16a.

Tenagogonus opacus Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 209.

Twenty-five macropterous specimens. Near New Amsterdam, British Guiana, S. A.; Mera, and Tena, Ecuador; Ft. Clayton, C. Z.

4. *Tenagogonus duolineatus* sp. nov.

(Plate X, figs. 4, 4a)

Size.—Length (in mm.) of winged males, 7.5 to 8.3; width, 2.2 to 2.6; of winged females, 9.7 to 10.2; width, 2.6 to 2.8.

Color.—Only winged forms known. Head fulvous to ochraceous with median ochraceous line on anterior lobe which runs out about middle of posterior lobe. Lateral and posterior margins ochraceous to fulvous. Two broad fulvous lines bordered by black on anterior lobe of pronotum. Hemelytra fuscous with dark-brown nervures. Dark-brown line behind eye which is indistinct or tapers out on mesopleura. Rostrum light, last segment black. Antennae brown-

ish, apex of last segment darker. Broad black line beginning behind coxa of anterior legs, running out beyond middle of mesothorax. Silvery spots on meso- and meta-acetabula. Prosternum light, meso- and metasterna light with a silvery sheen.

Structural characteristics.—Antennal formula of males: 57:37:66:102; females, 68:48:77:109. The last segment distinctly twice as long as second. Rostrum almost reaching to middle of mesosternum. Mesosternum deeply, narrowly channeled. Male last ventral abdominal segment deeply and doubly emarginate, shorter than preceding two segments. Metasternum with prominent carina. Fore femur slightly curved; length, 2.1 mm.; light basally and darker apically. Tibia slightly curved; length, 1.97 mm.; dark brown. First genital lightly transversely impressed near middle of segment. A patch of silvery hairs on either side of median line. Both genital segments hairy. Female is larger, stouter than male. Mesosternum very shallowly channeled. Last ventral abdominal segment produced, very broadly truncate. Connexival spines produced into long moderately stout spines which bend toward median line slightly; the basal part light, the distal part black with many hairs; they extend over half their length beyond posterior margin of last venter. Connexiva moderately broad.

Types.—Holotype, allotype, and forty paratypes in the Francis Huntington Snow Entomological collections; University of Kansas. The types were taken from Santos, Bolivia, S. A.; Dept. Haianuco, Peru, S. A.; R. Beni Cachuela, Esperanza, Bolivia, S. A.; Villarrica, Paraguay, S. A.; Vic. San Pedro, 900 m. a. s. l., Peru, S. A.; Rio Beni, Las Pampas, Bolivia, S. A.

Comparative notes.—Very closely related to *T. quadrilineatus.* The males have a shorter fore femur, deep and narrow channel on the mesosternum, and a much more distinctly doubly emarginate sixth venter. The females have much longer connexival processes and a very broad truncate last ventral abdominal segment.

5. *Tengogonus quadrilineatus* (Champion)

(Plate X, figs. 5, 5a)

Limnometra quadrilineata Champion, Biol. Centr.-Amer., Rhynch., II, 1898, pp. 150, 151, Pl. IX, fig. 17.

Tenagogonus quadrilineatus Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., 1908, p. 209; Drake and Harris, Ohio Jour. Sci., XXVII, 1928, p. 273.

Two hundred and nine macropterous and several brachypterous specimens. These from San José, Costa Rica, C. A.; Riovirilla, Costa Rica, C. A.; Michoacan, Mex.; Guadalupe, Chiapas, Mes.; Rio Mayo Sonora, Mex.; El Salto Excuintla, Guatamela.

IV. Genus CYLINDROSTETHUS Mayr, 1865

Haplotype, *ficberi* Mayr, 1865 (= *producta* Spinola, 1840)

Hydrobates Erichson, in Schomburgk's Faun. Brit. Guinana, III, 1848, p. 614 (*nec.* Boie).
Cylindrostethus Fieber, Europ. Hemip., 1861, p. 33 (invalid); Mayr, Verh. Zool. Bot. Ges. Wein., XV, 1865, 444; Kirkaldy, Entomologist, XXX, 1897, 258; Bergroth, Ent. Mo. Mag., XIII, 1902, p. 258; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 210; Schmidt, Stett. Ent. Zeit., 76, 1915, p. 361; Torre-Bueno, Spolia Zeylandica, 13, 1925, p. 226.
Janias Distant, Fauna Br Ind., Rhynch., V. 1910, p. 148; Esaki, Ann. Mag. Nat. Hist., (10) 4, 1929, p. 416.

Body very elongate, cylindrical; antennae rather slender, moderately long; intermediate and posterior legs extremely long, their femora extending to or even a little beyond the last genital segment; front tarsi with segment II twice as long as I. Rostrum short, not attaining middle of prosternum. Eyes large, long, not exserted, placed obliquely on the sides of the head. Metasternum divided by a sinuate, transverse suture a little before hind margin. In apterous form pronotum rather short, not produced behind over mesonotum.

This genus is represented in the Western Hemisphere by six species. Winged forms of American species seem to be exceedingly rare and, herein, for the first time, a winged form is described.

KEY TO SPECIES OF CYLINDROSTETHUS

1a. Sixth venter of male doubly emarginate at apex (with a deep notch at the middle). mesonotum unicolorous, brownish to brownish black, longitudinally impressed along the sides 2a

1b. Sixth venter of male with a broad simple emargination at apex (without median notch). Mesonotum brownish, with conspicuous fuscous to black longitudinal stripes 4a

2a. Venters of fifth and sixth abdominal segments of male without evidence of median impression. Posterior margin or dorsum of mesothorax of female with two median, posterio-dorsally directed lobes ..... *bilobata* sp. nov.

2b. Venters of fifth and sixth (or just the sixth) abdominal segments impressed. Posterior margin of dorsum of mesothorax of female without two median posterio-dorsally directed lobes 3a

3a. Mesonotum dark, fuscus to black. Male with fifth and sixth abdominal venters medianly impressed, connexival spines very stout, abdomen widened posteriorly. *erythropus* (Herrich-Schaeffer)

3b. Mesonotum brownish, testaceous. Male with only sixth abdominal venter impressed on either side of a median ridge, connexival spines more slender, abdomen widening slightly, posteriorly ..... *linearis* Erichson

4a. Length of first antennal segment subequal to width of head through eyes. Dark lines on mesothorax narrow and becoming indistinct posteriorly, connexival spines very short ..... *hungerfordi* Drake & Harris

4b. Length of first antennal segment greater than width of head through eyes, dark lines on dorsum of mesothorax wide and prominent and extending over metanotum, connexival spines longer 5a

5a. First two antennal segments black. Connexival spines of male almost reaching to middle of first genital segment, pronotum of winged form extending to metanotum, black, except on margins and disc yellowish; female with connexival spines long, reflexed, and contiguous above genital segment, first genital longer than broad and ending in an acute point ..... *palmaris* Drake & Harris

5b. First two antennal segments lighter, largely testaceous; connexival spines short, extending only a short distance past base of first genital; connexival spines of female shorter, first genital longer than broad but rounded on posterior dorsal margin. *regulus* (White)

1. *Cylindrostethus erythropus* (Herrich-Schaeffer)

Hydrometra erythropus (Herrich-Schaeffer) Wanz. Inst., IX, 1850, p. 68, fig. 923. *Cylindrostethus erythropus* Schmidt, Stett. Ent. Zeit., 76, 1915, p. 362; Drake and Harris, Ann. of Carn. Mus., XXIII, p. 219, Pl. XXV, fig. e.

Two hundred and fifty-six apterous specimens. Solimoes River, Amazonas, Brazil, S. A.; Vic. Santo Antonio River, Brazil, S. A.; Rio Puras, Lago Berury, Brazil, S. A.

2. *Cylindrostethus linearis* (Erichson)

Hydrobates linearis Erichson, in Schomburgk's Fauna Brit. Guiana, III, 18, p. 164.
Cylindrostethus linearis (Erichson), Drake and Harris, Ann. Carn. Mus., 1934, XXIII, p. 220, Pl. XXV, fig. f.

Three hundred and thirty-two apterous specimens. Rio Madeira, Porto Velho, Brazil, S. A.; Vic. Joao Pessoa, Jurua River, Brazil, S. A.; Vic. Santo Antonio River, Eiru, Brazil, S. A.

3. *Cylindrostethus hungerfordi* Drake & Harris

Cylindrostethus hungerfordi Drake & Harris, Ann. of Carn. Mus., XXIII, p. 221, 1934

Holotype, allotype, and 4 paratypes. Four apterous specimens. Near New Amsterdam, British Guiana, S. A.

4. *Cylindrostethus palmaris* Drake and Harris

Cylindrostethus linearis Drake and Harris (*nec.* Erichson) Ann. Carn. Mus., XIX, 1930, p. 238.

Four hundred and four apterous and twenty-five macropterous specimens. Heretofore only wingless forms have been known in the genus. Apterous specimens from Lago Grande, state of Para, Brazil, S. A.

DESCRIPTION OF WINGED FORM

Size.—Length of males, 17 mm. to 19.5 mm., width: 2.5 to 3.5 mm.; females, length: 20 to 22.5 mm., width: 2.8 to 3.5 mm.

Color.—Head flavous. Base of antennae black. Pronotum black with lateral and caudal margins flavous; broadly rounded posteriorly, slightly carinate. Anterior lobe with a large heart-shaped flavous spot, median depression; posterior lobe transversely depressed on the posterior margin of the anterior third. Humeri moderately prominent, a slight transverse elevation between them. Surface of pronotum punctated, covered with short hairs. Hemelytra sometimes attaining the anterior margin of last abdominal segment and sometimes surpassing the posterior margin; uniformly brown except fulvous costal margin, nervures prominent.

Types.—Holomorphotype, allomorphotype, and 23 paramorphotypes. The holomorphotype, allomorphotype, and 15 paramorpho-

types from Esperanza, R. Beni Cachuela, Bolivia, S. A.; others from Supuruni Creek, British Guiana and Manaos Region, Rio Negro, Brazil, S. A.

In describing *C. palmaris* Drake and Harris credited the holotype and allotype from "Manacapura Amazones (Solimoes River) Brazil, June, 1926, S. M. Klages" as belonging to the Carnegie Museum. This was an error. They are the property of the University of Kansas as there is documentary evidence from S. M. Klages to prove this, and they should be returned to the University of Kansas.

5. *Cylindrostethus regulus* (White)

Halobates regulus White, Journ. Linn. Soc. London, Zool., XIV, 1879, p. 488.
Cylindrostethus regulus Drake and Harris, Ann. Carn. Mus., XIX, 1930, p. 238, *ibid.* XXIII, 1934, p. 222.

Forty-one apterous specimens from following: R. Amazonas, Region de Itacoatiara, Brazil, S. A.; Vic. Santo Antonio, River Eiru, Brazil, S. A.; Vic. Joao Pessoa, River Jurua, Brazil, S. A.

6. *Cylindrostethus bilobata* Sp. n.

(Fig. 1)

Size.—Length of male, 14.00-15.00 mm.; width, 2.00-2.50 mm.; length of female, 16.00-17.00 mm.; width, 2.00-2.50 mm.

Color.—Dorsum and dorsolateral areas dark brown to black, connexiva much lighter, almost yellowish. Venter, not including anterior portion of mesonotum, light yellowish-brown. Pronotum with median longitudinal yellowish line. Head light brownish, antennal tubercles black, antennae brown. Anterior femora with yellowish stripe on dorsal side for three quarters of its basal length. Middle and hind femora long and thin, yellowish in color except at apices, tibia brown.

Structural characteristics.—Antennal proportions of male, 122:52:33:64; female, 151:55:33:66. Mesonotum longitudinally impressed along the dorsolateral sides. Abdomen parallel sided, connexival spines shorter and stouter than in *C. linearis* (Erichson). In the male the first genital above longitudinally impressed laterally, narrowing slightly posteriorly, the posterior margin subrounded; below it widens until the middle and then narrows posteriorly. The connexival spines are conical and directed posteriorly, slightly divergent. The last genital segment conical, shorter than the first, with moderately strong, triangular ventral antero-laterally projecting plates. In the female the caudal margin of mesonotum with two median dorso-posteriorly directed lobes, connexival spines much

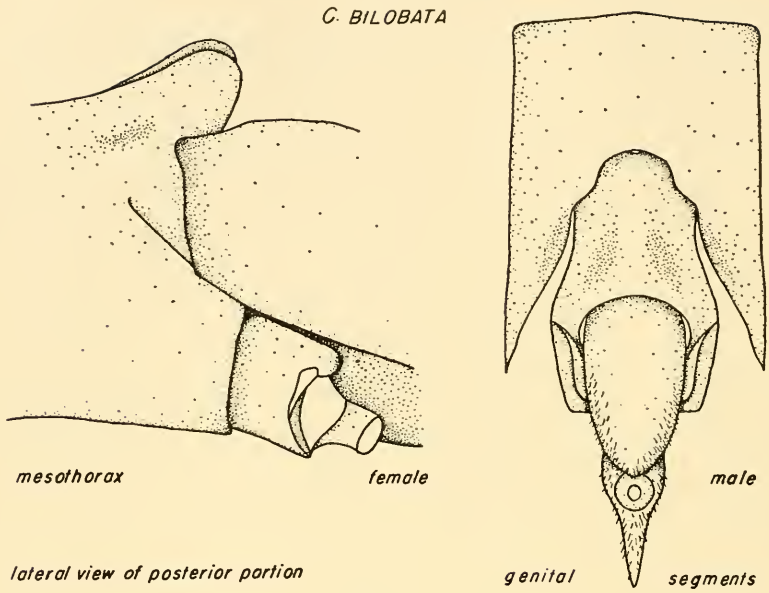


FIG. I.

shorter and ending in sharper points than in the male. Posteriorly, the connexiva fold medianly enveloping the abdomen; the spines are directed posteriorly and almost meet at the middle on the caudal margin. The first genital narrows posteriorly, laterally impressed on each side ventrally, dorsally rounded at apex. Last genital segment ending in a point, about as long as preceding one.

Comparative notes.—Very close to *C. linearis* (Erichson). The male differs from *C. linearis* in that the abdomen does not widen posteriorly, the connexival spines are a little shorter and stouter, the last abdominal venter is deeply and roundly excavated with an inconspicuous median tooth, and the ventral antero-laterally projecting plates distinctly shorter than in *C. linearis*. The females differ by having two dorso-posteriorly pointing median lobes on the caudal margin of the mesonotum and the connexiva folding medianly so that the very short, posteriorly directed, spines almost meet medianly.

Types.—Holotype, allotype, and four male and one female paratypes. All specimens bear the following label: Bolivia, S. A., River Beni Puerto, Salinas, 11-37, A. M. Olalla. Types in the Francis Huntington Snow Entomological Museum.

V. Genus POTAMOBATES Champion, 1898

Logotype, *unidentatus* Champion

Potamobates Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 154; Kirkaldy, Trans. Amer. Ent. Soc., XXXII, 1906, p. 155; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 211.

Eyes oblique, not strongly exserted, coarsely faceted, feebly emarginate within posteriorly, rather narrowly separated anteriorly. Rostrum short, reaching to the mesosternum. Head subtriangular, produced and declivous in front. Anterior legs short, the femora stout and incrassate towards base; tarsi with basal segment short, less than half as long as the second; coxae widely separated. Middle and hind legs very elongate, the former longer; femora of hind legs longer and slenderer than intermediate ones; second segment of hind tarsi much shorter than first. Thorax elongate-trapezoidal, widening to the intermediate acetabula; pleura prominent, rounded externally; pronotum short, not produced behind in apterous form, covering the mesonotum in the winged form. Mesonotum flattened and shiny in apterous individuals.

The genital segments are asymmetrical in the male, and also in the female in some species. The left side of the second genital segment is produced postero-laterally into a peculiar platelike structure in the male in certain species, thus somewhat reminding one of the projections from this segment in *Cylindrostethus;* however, in American species belonging to the latter genus the genital segments are bilaterally symmetrical. Also it should be noted that the metasternum is divided by a transverse suture a little before its hind margin, the omphalium being placed in this suture as in *Cylindrostethus.* A few workers have erroneously considered the basal part of this division of the metasternum as the first segment of the venter, which in their opinion possesses seven visible segments instead of six. In both *Cylindrostethus* and *Potamobates* the anal opening is closed by a hard, circular, platelike structure. Champion considered the genus to form a sort of connecting link between the *Gerrinae* and the freshwater *Halobatine* forms.

This interesting genus of water striders extends from Mexico to Peru. Two species described from Mexico; three from Costa Rica; one from Colombia, S. A.; one from Ecuador; and three from Peru. Ten species are known.

KEY TO SPECIES OF POTAMOBATES

1a. Males 2a
1b. Females 11a
2a. First genital segment with longitudinal sulcus 3a
2b. First genital segment without longitudinal sulcus 10a
3a. Hooklike projection of second genital segment provided with a large retrorsely and dorsally directed prong on caudal margin ..... *variabilis* Hunderford
3b. Hooklike projection of second genital segment not provided with a large retrorsely and dorsally directed prong on caudal margin 4a
4a. Posteriolateral margin on right side of first genital segment with one or more projections 5a
4b. Posteriolateral margin without projections 8a
5a. Projections on first genital segment almost as wide as long, blunt, unequal in size. *woytkowskii* Hungerford
5b. Projections on first genital segment, long, narrow and sharp 6a
6a. First genital segment with only one projection ..... *peruvianus* Hungerford
6b. First genital segment with two projections 7a
7a. Toothlike projections on first genital segment widely separated; hooklike tooth of second genital segment begins to right of median line, terminates in cleft between projections of first genital segment ..... *williamsi* Hungerford
7b. Toothlike projections close together; tooth of second genital segment begins to left of median line, terminates some distance before cleft between teeth of first genital segment ..... *tridentatus* Esaki
8a. First genital segment without a projection ..... *osborni* Drake & Harris
8b. First genital with one projection on caudo-ventral margin 9a
9a. Projection almost medianly situated on ventral side ..... *horvathi* Esaki
9b. Projection on first genital segment laterally situated on left side. *unidentatus* Champion
10a. Two projections on caudo-ventral margin of first genital segment. *bidentatus* Champion
10b. First genital segment without projections ..... *thomasi* Hungerford
11a. Connexiva produced into long, finger-like process 12a
11b. Connexiva not produced into long, fingerlike process 16a
12a. Connexival process shorter than genital segments and first dorsal genital segment without twisted fingerlike process ..... *variabilis* Hungerford
12b. Connexival process longer than genital segments or the first dorsal genital segment with twisted fingerlike process 13a
13a. First genital ventral plate large; left half produced caudally into a broad, flat, variable plate as long as basal half (or) connexival process as long as four preceding tergites ..... *woytkowskii* Hungerford
13b. First genital ventral plate not greatly produced on left side; connexival process shorter, as long as two preceding tergites 14a
14a. Last ventral abdominal segment on median line, longer than rest of preceding abdominal segments together ..... *peruvianus* Hungerford
14b. Last ventral abdominal segment on median line, shorter than rest of preceding abdominal segments together 15a
15a. First dorsal genital not produced into twisted process; connexival process longer than genital segments ..... *williamsi* Hungerford
15b. First dorsal genital produced into twisted process; connexival process shorter than genital segments ..... *tridentatus* Esaki
16a. First dorsal genital segment produced into a fingerlike process. *osborni* Drake & Harris
16b. First dorsal genital not produced into a fingerlike process 17a
17a. Second genital not exposed ..... *unidentatus* Champion
17b. Second genital exposed as a cylindrical segment 18a
18a. Connexiva not produced into spines ..... *horvathi* Esaki
18b. Connexiva produced into spines ..... *thomasi* Hungerford

1. *Potamobates variabilis* Hungerford

Potamobates variabilis Hungerford, Jour. Kan. Ent. Soc., July, 1938, XI, No. 3, pp. 85-87.

Holotype, allotype, and two paratypes. Twenty-three apterous specimens. All from vicinity of Afilador, Peru, S. A.

2. *Potamobates woytkowskii* Hungerford

Potamobates woytkowskii Hungerford, Bull. Brook. Ent. Soc. XXXII, No. 4, pp. 144-145.

Holotype, allotype, and fourteen paratypes. Thirty-seven apterous specimens. Vicinity of Rioja, Dept. San Martin, Peru, S. A.

3. *Potamobates peruvianus* Hungerford

Potamobates peruvianus Hungerford, Bull. Brook. Ent. Soc., XXXI, pp. 178-180.

Holotype, allotype, and eighty-three paratypes. Forty-nine apterous and macropterous specimens. Vicinity of Sani Beni, Peru, S. A.

4. *Potamobates williamsi* Hungerford

Potamobates williamsi Hungerford, Bull. Brook. Ent. Soc. XXVII, 1932, p. 228.

Holotype, allotype, and seventeen paratypes. Two hundred and five specimens, apterous and macropterous forms. Types from Tena and Mera, Ecuador, S. A.; others: Rio-Napo water shed, Jotun, Yacu, Ecuador, S. A.; Puyo near Mera Oriente, Ecuador, S. A.; Tena and Mera, Ecuador, S. A.

5. *Potamobates tridentatus* Esaki

Potamobates tridentatus Esaki, Ann. Mus. Nat. Hung., XXIII, 1926, p. 251, fig. 1.

Apterous and macropterous forms. San Isidro del. Gen., Costa Rica, C. A.; Ft. Clayton, Canal Zone. Not heretofore known from Canal Zone. Eleven specimens, one winged male.

6. *Potamobates osborni* Drake and Harris

Potamobates osborni Drake and Harris, Proc. Biol. Soc. Wash., 41, 1928, p. 25.

No representatives.

7. *Potamobates horvathi* Esaki

Potamobates horvathi Esaki, Ann. Mus. Nat. Hung., XXIII, 1926, p. 254, fig. 2; Drake and Harris, Proc. Biol. Soc. Wash., 41, 1928, p. 26.

Two hundred and two apterous and one macropterous specimens. Punta Gorda, British Honduras, C. A.; Ft. Clayton, Canal Zone; Les Amates, Guatemala; San Vicenti Chiapas, Mexico. Not heretofore recorded from Canal Zone.

8. *Potamobates unidentatus* Champion

Potamobates unidentatus Champion, Biol. Centr.-Amer. Rhynch., II, 1898, p. 155; Esaki, Ann. Mus. Nat. Hung., XXIII, 1926, p. 251.

All apterous specimens. Eleven specimens from San Isidro del Gen., Costa Rica, C. A.

9. *Potamobates bidentatus* Champion

Potamobates bidentatus Champion, Biol. Cent.-Amer., Rhynch., II, 1898, p. 155; Pl. IX, figs. 22 and 22a.

No representatives. Two female specimens similar to *Potamobates tridentatus* but lacking the twisted process of the first dorsal genital segment, have been placed here for the present.

10. *Potamobates thomasi* Hungerford

Potamobates thomasi Hungerford, Journ. Kan. Ent. Soc., Vol. 10, No. 2, April, 1937, pp. 63-65.

Holotype, allotype, and ten paratypes. Apterous and macropterous specimens. Twenty-five specimens. El Sabino, Uruapan, Michoacan, Mexico; District of Temascaltepec, Tejupilco, Mexico.

PLATE X

Tenagogonus opacus Champion
- FIG. 1. Ventral view of female last abdominal segment.
- FIG. 1a. Lateral view of male genital segments.

Tenagogonus celocis Drake and Harris
- FIG. 2. Ventral view of female last abdominal segment.
- FIG. 2a. Lateral view of male genital segments.

Tenagogonus spinulatus sp. n.
- FIG. 3. Ventral view of female last abdominal segment.
- FIG. 3a. Lateral view of male genital segments.

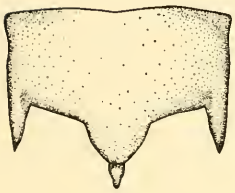
Tenagogonus duolineatus sp. n.
- FIG. 4. Ventral view of female last abdominal segment.
- FIG. 4a. Ventral view of male genital segments.

Tenagogonus quadrilineatus (Champion)
- FIG. 5. Ventral view of female last abdominal segment.
- FIG. 5a. Ventral view of male genital segments.

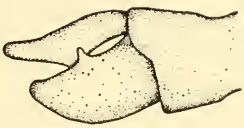
PLATE X

1a.

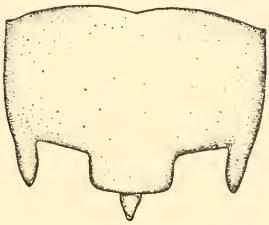
2a



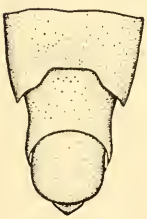
1. T. OPACUS



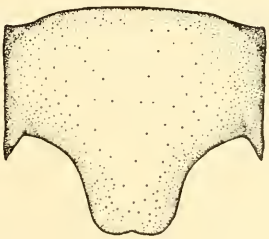
3a.



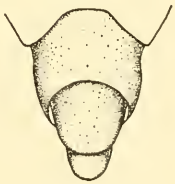
2. T. CELOCIS



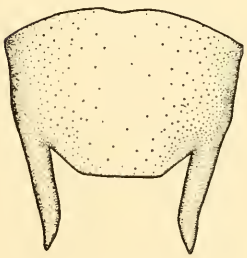
4a.



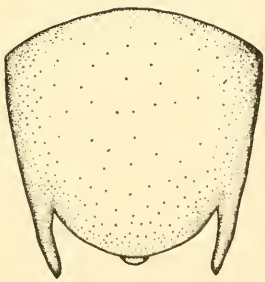
3. T. SPINULATUS



5a



4. T. DUOLINEATUS



5. T. QUADRILINEATUS

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A Revision of the Genus Aligia (Homoptera Cicadellidae) North of Mexico

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ABSTRACT: This paper is a taxonomic study of the species included in the genus *Aligia* since its erection by Dr. E. D. Ball in 1907. The following fourteen species are retained: *dellana, manitou, chiricana, occidentalis, turbinata, santana, modesta, colei, californica, inscripta, descripta, munda, oculea,* and *jucunda.* In the Journal of the Kansas Entomological Society for October, 1939, the following sixteen new species and two new subspecies were described: *pallida, lutea, meridiana, bifurcata, acutata, pallidinota, obesa, rotunda, bifasciata, reticulata, atrivena, magna, obtusa, falcata, curtipennis, utahna, dellana suffusca* and *chiricana alta.* Negative prints of the male genital structures, a key separating all the species in the genus, and new descriptions of all species are all included in the paper.

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INTRODUCTION

THE genus *Aligia* was separated from *Eutettix* by Dr. E. D. Ball (Proceedings of the Davenport Academy of Sciences, Vol. 12, pp. 27-94, 1907) with *Jassus jucundus* Uhler as the orthotype and five other species included: *Allygus inscriptus* Van Duzee, *Eutettix munda* Ball, *Eutettix manitou* Ball, *Eutettix modesta* Osborne and Ball, and *Eutettix oculea* Ball. *Aligia amoena* Van Duzee, described in 1923, has been placed in the genus *Dixianus*. *A. californica, A. colei,* and *A. occidentalis* were described by Van Duzee in 1925 and *A. descripta, A. dellana, A. turbinata, A. chiricana* and *A. santana* by Dr. E. D. Ball in 1931. The following sixteen species and two subspecies were described in 1939: *A. pallida, A. lutea, A. meridiana, A. bifurcata, A. acutata, A. pallidinota, A. obesa, A. rotunda, A. bifasciata, A. reticulata, A. atrivena, A. magna, A. obtusa, A. falcata, A. curtipennis, A. utahna, A. dellana suffusca,* and *A. chiricana alta.* Types of all species, unless otherwise stated, are in the Francis

Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kan.

Host plants of this genus consist of various species of oaks, although one species, *A. oculea,* is found on the service-berry. The greatest number of species is found in the Southwest, with the eastern half of the United States represented by only two known species, *A. modesta* and *A. meridiana.*

ACKNOWLEDGMENTS

I am deeply indebted to Dr. R. H. Beamer of the University of Kansas for assistance and suggestions in the taxonomic problems involved, as well as for the collecting of most of the specimens examined. Sincere appreciation is expressed to Mr. R. A. Flock and Dr. E. D. Ball, University of Arizona; Dr. P. W. Oman, National Museum; Dr. Maurice James, Colorado State College; Dr. George F. Knowlton, Utah State College; Dr. H. H. Knight, Iowa State College and Mr. E. W. Davis, Modesta, Cal.

TECHNIQUE OF STUDY

The abdomen of the male was broken from the specimen and heated in a ten percent solution of caustic potash for two to five minutes, rinsed in water and placed in glycerine on a slide. The plates and pygofers, with their respective parts, were separated, flattened and studied. A cover slide was then placed over each one and negative prints made of each dissection. Most of the comparisons were made from these prints. The genital structures were mounted in diaphane before making the prints used in this paper.

CHARACTERS USED IN CLASSIFICATION

Characters of the internal male genitalia proved to be the most important criteria for separation into species. The shape and size of the pygofer hook, pygofer and aedeagus were of primary importance with the appearance of the styles used to a lesser degree. Dissection of the female internal genitalia showed no distinctive character that might be used to separate them. External genital structures of both sexes proved to be equally unimportant.

The most important external characters were shape and venation of tegmina, color of veins, color pattern, shape of vertex and size of the individuals.

The length of specimens refers to distance from tip of vertex to apex of tegmina. The width of the pygofer is the distance across it

at the posterior point of the attachment of the pygofer hook; the length is the distance from this point to the apex. Width of styles at the base is the distance between the two anterior processes; length refers to the distance from this line to the apex.

SYNOPSIS OF GENUS

The genus *Aligia* resembles *Eutettix* but with second cross nervure always present and usually with more cross veins throughout tegmina.

Clypeus wedge shaped, not constricted between antennae; margins of lorae circular. Vertex flat, varying from circular to sharply pointed; transverse furrow present although sometimes indistinct. Tegmina long, usually flaring; cross veins usually numerous, especially in corium next clavus (cell Cu), middle anteapical cell (cell M_2), and in costa (cell C).

Typical color pattern, if present.—Lorae with black dot on each lateral margin; vertex with a pair of dots at apex and two pairs just inside each eye; transverse furrow dark. Pronotum darker than vertex with three pairs of dark spots on anterior margin. Scutellum with five ivory spots, two on each lateral margin and one at apex, a large spot inside each basal angle, two smaller spots just inside these and a median spot just below transverse suture, darker. Band across second cross nervure and area just before apex, lighter.

Genitalia.—Pygofer triangular to oval; pygofer hook prominent, single or bifurcate. Plates slender, pointed; aedeagus sometimes with a pair of processes near apex; styles sinuately narrowed from base to apex.

KEY TO THE SPECIES OF ALIGIA

1. Tegmen and general color light yellow to chestnut, veins same color as tegmen or darkening posteriorly 2
   Tegmen and general color pale or milky; veins fuscous..... 16
2. (1) Golden to reddish-brown throughout, except for a narrow semihyaline band across second cross nervure and near apex of tegmen; less than 4 mm. long; males 3
   Not golden to reddish-brown throughout, definite crossband or entire tegmina semihyaline to light yellow; more than 4 mm. long..... 6
3. (2) Color golden-yellow 4
   Color reddish-brown 5
4. (3) Pygofer hook with small recurved hook near apex; apex of aedeagus rounded; Arizona and adjacent areas of New Mexico and Utah.....*dellana* Ball
   Pygofer hook with small recurved hook near middle, apex of aedeagus bluntly pointed; Colorado and adjacent areas of New Mexico and Utah.
   manitou (Ball)
5. (3) Pygofer hook with two large forks, shaft of aedeagus long; Arizona.
   chiricana Ball
   Pygofer hook with small recurved process near apex, shaft of aedeagus shorter; California .....*dellana suffusca* Hepner

6. (2) Crossband across second cross nervure absent or nearly so; tegmen about same color throughout 7
Crossband across second cross nervure distinct, dividing the tegmen into two darker areas 9
7. (6) Pygofer hook of male falcate; California.....*occidentalis* Van Duzee
Pygofer hook of male not falcate; Arizona..... 8
8. (7) Light yellow to green throughout; dorsal fork of pygofer hook broad at apex; ventral fork bifid .....*pallida* Hepner
Luteous throughout; both forks of pygofer hook slender and pointed.
lutea Hepner
9. (6) Males 4.5 mm. or less in length; females 5 mm. or less in length; western.. 10
Males more than 4.5 mm. in length; females more than 5 mm. in length; eastern and southern 15
10. (9) Tegmen anterior to crossband without light or semihyaline area..... 11
Tegmen anterior to cross band with light or semihyaline area..... 13
11. (10) Crossband opaque, white and without dark veins transversing it...*turbinata* Ball
Crossband semihyaline and transversed by darker veins, at least in middle... 12
12. (11) Pronotum and basal half of scutellum brown, usually with vermiculate markings.
chiricana Ball
Pronotum and scutellum light yellow to green without vermiculate markings.
chiricana alta Hepner
13. (10) Light area anterior to cross band restricted to very small area along margin next scutellum .....*santana* Ball
Light area anterior to cross vein covering at least basal fourth of tegmen.... 14
14. (13) Vertex definitely rounded, pronotum darkly inscribed; color brown; California.
dellana suffusca Hepner
Vertex definitely angled, pronotum lightly inscribed, if at all; color yellow to golden, not California.....*manitou* Ball
15. (9) Dull color, apex of pygofer pointed, middle western and eastern.
modesta (Osborn & Ball)
More brightly colored, apex of pygofer truncate; southern and middle western.
meridiana Hepner
16. (1) Tegmen uniformly inscribed with fuscous or brown; no crossband evident.... 17
Tegmen not uniformly inscribed with fuscous or brown; crossbands at least faintly indicated 20
17. (16) Margins of vertex parallel or nearly so; veins brown, transverse furrow shallow.
bifurcata Hepner
Vertex produced at middle, veins dark, transverse furrow prominent..... 18
18. (17) Forks of pygofer hook about equal in width, ventral fork arising posteriorly, Arizona .....*acutata* Hepner
If pygofer hook bifid, ventral fork narrower and arising anteriorly, California, 19
19. (18) Markings on vertex and scutellum usually indistinct, vertex less than twice as wide between eyes as length at middle, pygofer hook bifid..*colei* Van Duzee
Markings on vertex and scutellum usually distinct, vertex more than twice as wide between eyes as length at middle, pygofer hook falcate.
californica Van Duzee
20. (16) Crossbands of tegmen dark and distinct..... 21
Crossbands of tegmen light, less distinct..... 25
21. (20) Vertex angular, less than three times as wide between eyes as length at middle; California 22
Vertex almost parallel margined, more than three times as wide between eyes as length at middle, not California..... 23
22. (21) Scutellum reddish-brown to fuscous; margins of shaft of aedeagus parallel or nearly so .....*inscripta* (Van Duzee)
Scutellum light to yellow; margins of shaft of aedeagus enlarged at base and at apex in lateral view.....*pallidinota* Hepner
23. (21) Dots at apex of vertex light, tegmen narrowed posteriorly, Texas and New Mexico .....*obesa* Hepner
Dots at apex of vertex dark, tegmen not narrowed posteriorly, Arizona..... 24

24. (23) Small, male 4 mm. or less in length, female 4.5 mm. or less in length; basal fork of pygofer hook not enlarged at base.....*rotunda* Hepner
Larger, male over 4 mm. in length, female over 4.5 mm. in length, basal fork of pygofer hook enlarged at base.....*bifasciata* Hepner
25. (20) Numerous eross veins in tegmen, eight or more cross veins in costa more or less evenly spaced along the entire length..... 26
Less eross veins in tegmen, less than eight in eosta arranged in two or three groups..... 30
26. (25) Males 4.5 mm. or less in length; females 5.5 mm. or less in length..... 27
Males more than 4.5 mm. in length; females more than 5.5 mm. in length.. 28
27. (26) Vertex produced, twiee as wide or less between eyes as length at middle; forks of pygofer hook about equal in length.....*descripta* Ball
Margins of vertex about parallel, more than twiee as wide between eyes as length at middle; ventral fork much shorter than dorsal....*reticulata* Hepner
28. (26) Pygofer hook falcate.....*atrivena* Hepner
Pygofer hook not falcate..... 29
29. (28) Aedeagus with short lateral proeesses, ventral fork of pygofer hook enlarged near apex.....*magna* Hepner
Aedeagus without lateral proeesses, apex of ventral fork of pygofer hook aeutely pointed.....*munda* (Ball)
30. (25) Corium next claval suture without eross veins, pygofer hook with short, sharp, recurved process near apex.....*dellana* Ball
Corium next claval suture with many eross veins, pygofer hook without short, sharp, reeurved process near apex..... 31
31. (30) Vertex short, over three times as broad between eyes as length at middle.... 32
Vertex more produced, less than three times as broad between eyes as length at middle..... 33
32. (31) Males less than 5 mm. long; females less than 6 mm. long; pygofer hook narrowest near middle.....*obtusa* Hepner
Males more than 5 mm. long; females more than 6 mm. long; pygofer hook nearly same width throughout.....*falcata* Hepner
33. (31) Eyes bright red, basal angles of scutellum blaek.....*oculea* (Ball)
Eyes not bright red, basal angles of scutellum brown..... 34
34. (33) Pygofer hook short, bent into gooseneek near base, broadest on outer third; shaft of aedeagus very short.....*curtipennis* Hepner
Pygofer hook longer, distinctly falcate, nearly same width throughout; shaft of aedeagus longer..... 35
35. (34) Markings blaek, vertex relatively flat and pointed, erossband lighter; aedeagus long; Utah.....*utahna* Hepner
Markings brown to fuseous, vertex convex and shorter, crossband darker; aedeagus shorter; Colorado, New Mexico, Arizona and eastern Utah.
jucunda (Uhler)

Aligia dellana Ball

(Plate XI, fig. 1)

Aligia manitou dellana, Ball, E. D., Pan Pae. Ent. VII, p. 120, 1931.

Resembling *manitou*, but without golden-brown bands in the female and with process of pygofer hook of male on dorsal margin near apex. Color quite variable. Length: Male, 4 mm.; female, 4.75 mm.

Margin of vertex variable, transverse furrow shallow. Cross veins few in number.

Color.—Vertex and scutellum in the female ivory yellow with typical markings dark, pronotum grey more or less irrorate with fuscous excepting lateral and posterior margins and a longitudinal median vitta. Tegmen semihyaline with dark veins and few irregular dark

markings. Vertex of male lemon yellow, pronotum dark grey with three pairs of darker markings along anterior margin quite distinct, scutellum yellowish-grey with typical markings more or less obscure. Tegmen semihyaline with dark veins, apex of clavus and occasionally one or two irregular spots, fuscous.

Genitalia.—Pygofer rounded at apex, about two-thirds as wide at constriction as distance from there to apex; pygofer hook extending to apex of pygofer, twisted at middle, enlarged on outer fourth, short, sharp, recurved process on dorsal margin at apex. Aedeagus in lateral view about four times as long as basal width, curved strongly on basal third, narrowing gradually to about one-half basal width on outer fourth, enlarged slightly, then rounded to apex; in ventral view parallel sided, bifurcate on outer fifth, and bearing a pair of lateral processes about one-third length of shaft of aedeagus. Styles slightly more than three times as long as basal width, sinuately narrowed to outer fifth, apices sharp.

Types.—Holotype female, allotype male in the E. D. Ball collection, National Museum, Washington, D. C.

Material studied. — Sixty-seven females, 10 males, Mountain Springs, Cal., July 25, 1938; 3 females, 3 males, Boulevard, Cal., July 26, 1938; 1 male, San Jacinto Mts., Cal., May 4, 1935, 3 females, Aug. 6, 1935; 2 males, Anza, Cal., July 29, 1938; 2 males, Idyllwild, Cal., Aug. 3, 1935; 7 females, Prescott, Ariz., July 29, 1933; 12 females, Yarnell, Ariz., July 29, 1933, 2 females, 2 males, July 25, 1932, 2 females, 1 male, Oct. 8, 1929, 8 females, 25 males, June 29, 1933; 1 female, Oak Creek Canyon, Ariz., Aug. 14, 1927; 3 females, 1 male, Granite Dell, Ariz., July 30, 1933, 2 females, 4 males, July 17, 1929; 1 female, Ashfork, Ariz., Aug. 8, 1932; 1 male Yavapai Co., Ariz., July 1, 1932; 1 female, Jerome, Ariz., July 30, 1933; 1 female, 1 male, Chiricahua Mts., Ariz., July 8, 1932, 1 male, June 9, 1933, 2 males, July 24, 1935, 1 male, July 14, 1938; 1 female, 2 males, Williams, Ariz., July 13, 1929; 1 male, Kirkland Junction, Ariz., June 29, 1933; 3 females, 1 male, Patagonia, Ariz., June 24, 1933; 25 females, 13 males, Silver City, N. M., July 23, 1936; 17 females, Leeds, Utah, Nov. 15, 1932; 7 females, St. George, Utah, Nov. 15, 1932; 1 male, Pintura, Utah, Oct. 20, 1930, 1 female, Beaver, Utah, July 29, 1930.

In this species there is either a great deal of variation in color and distribution or else several closely related varieties occur that might be separated by host plant studies. The females may be almost colorless, as are those from California, a reddish-yellow color, or

even almost black. The males may be golden-yellow or may resemble the females in color.

Aligia manitou (Ball)

(Plate XI, fig. 2)

Eutettix manitou, Ball, E. D., Can. Ent. XXXIII, p. 49, 1901.

Resembles *modesta*, but smaller, more brightly colored, with sharper vertex, less cross veins in tegmen, and pygofer hook with short recurved process. Length: Male, 4 mm.; female, 4.75 mm.

Vertex decidedly longer at middle than next eyes, transverse furrow shallow. Cross veins few in number.

Color.—Males golden yellow throughout, except semihyaline area near apex of tegmen and a few spots near second cross nervure. Females with vertex and scutellum ivory to yellow, faintly marked; pronotum slightly darker, more or less mottled with gray with indications of two longitudinal median darker vittae; tegmen semihyaline to white with two reddish-brown crossbands separated by a narrow light band, apical cells semihyaline to white.

Genitalia.—Pygofer blunt, much longer than width at constriction; pygofer hook extending almost to apex of pygofer, slender, bent into gooseneck near base, narrowing gradually to a sharp point; short, slender recurved process just beyond middle. Aedeagus in lateral view about three times as long as basal width, narrowed evenly to one-half basal width on outer third, slightly enlarged and tapering suddenly to a blunt point; a pair of lateral processes near apex about as long as basal width of aedeagus. Styles about three times as long as basal width, sinuately narrowing to one-fourth basal width on outer fifth, apex bluntly pointed.

Types.—Male lectoholotype, female lectoallotype, Dolores, Colo., Aug. 2, 1900, here designated in the Ball collection, National Museum, Washington, D. C.

Material studied.—One female, Salt Lake City, Utah, Sept. 25, 1932, 1 male, July 17, 1931; 5 females, 3 males, Richfield, Utah, Sept. 2, 1930; 2 males, Cove Fort, Utah, Aug. 14, 1929; 2 males, Alton, Utah, Aug. 11, 1936; 1 female, 5 males, Pintura, Utah, Aug. 11, 1929; 3 females, Zion National Park, Utah, Aug. 13, 1929; 1 female, 1 male, Manitou, Colo., July, 1900; 1 female, 1 male, Palmer Lake, Colo., June 18, 1901, 1 female, Sept. 18, 1901; 1 male, Colorado Springs, Colo., Aug.; 1 female, 9 males, Cimarron, N. Mex., Aug. 13, 1932; 6 females, 2 males, Colfax Co., N. Mex., Aug. 21, 1937.

The males of this species are typically golden yellow; occasionally one may be found similar to the females in color.

Aligia chiricana Ball

(Plate XI, fig. 3)

Aligia chiricana, Ball, E. D., Pan Pac. Ent., VII, p. 121, 1931.

Resembling *santana,* but with slightly pointed vertex, without light area near base of tegmen and with shaft of aedeagus much longer, males resembling *manitou,* but darker. Length: Males, 4 mm.; females, 5 mm.

Vertex rounded, slightly longer at middle than next eyes, about three times as wide between eyes as length at middle, transverse furrow shallow. Cross veins few in number.

Color.—Males brown with indication of light crossband. Females with vertex and scutellum ivory white to light yellow, typical markings fulvous; pronotum mottled brown. Tegmen semihyaline, except for narrow white band across second cross vein, apex of clavus and oftentimes small spots along commissure, darker; apical veins darker, occasionally bordered with fuscous.

Genitalia.—Pygofer acute, longer than width at constriction; pygofer hook bifid, dorsal fork extending almost to apex of pygofer, enlarged on outer half, pointed; ventral one about two-thirds as long, slightly more slender. Aedeagus in lateral view long, almost parallel margined, enlarged on outer fourth to twice basal diameter, apex blunt; in ventral view, bifurcate on outer fourth and bearing a pair of lateral processes about one-fifth length of shaft of aedeagus. Styles about two and one-half times as long as basal width, sinuately narrowing to a blunt apex.

Types.—Holotype female, allotype male in the E. D. Ball collection.

Material studied.—Seventeen females, Chiricahua National Monument, Ariz., Aug. 24, 1935; 21 females, 2 males, Chiricahua Mts., Ariz., June 14, 1938, 2 females, 4 males, June 9, 1933, 7 females, 1 male, July 8, 1932; 1 female, Oak Creek Canyon, Ariz., Aug. 9, 1932; 1 female, Jerome, Ariz., July 30, 1932.

Aligia dellana suffusca Hepner

Aligia dellana suffusca, Hepner, L. W., Jour. of Kan. Ent. Soc., XII, p. 105, 1939.

Resembles *dellana,* but usually darker with the aedeagus of the male somewhat longer. Length: Male, 4 mm.; female, 4.5 mm.

Vertex rounded, almost parallel margined, much wider between eyes than length at middle, transverse furrow almost absent. Cross veins in tegmen few in number.

Color.—Female with vertex and scutellum white to brown, with

typical markings sometimes evident, pronotum darker. Tegmen semihyaline to white with two crossbands yellow to brown, veins darkening posteriorly. Males with vertex and scutellum yellow to brown with typical markings seldom evident. Tegmen light brown to fuscous excepting few spots semihyaline to white in a band across second cross nervure and in region of anteapical cells and two or three fuscous spots in clavus. Veins darkening posteriorly.

Genitalia.—Pygofer somewhat more oval and shorter than *dellana,* about three-fourths as wide at constriction as distance from there to apex; pygofer hook extending to apex of pygofer, twisted near middle, almost parallel-sided to outer fifth with short, sharp, recurved process on dorsal margin near apex. Aedeagus in lateral view longer than *dellana,* about five times as long as basal width, curved strongly on basal third, narrowing gradually to less than one-half basal width at middle, almost parallel margined to apex; in ventral view parallel sided, bifurcate on outer fourth and bearing a pair of lateral processes about one-third length of shaft of aedeagus. Styles about three times as long as basal width, sinuately narrowed to one-fifth basal width on outer fourth, apices bluntly pointed.

Types.—Holotype male, allotype female, and 5 female and 2 male paratypes, Arroyo Seco River, Cal., Aug. 8, 1939, R. H. Beamer in the Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kan. Other paratypes as follows: 4 females, Arroyo Seco River, Cal., Aug. 8, 1938, L. W. Hepner, 1 male, R. I. Sailer; 8 females, 5 males, Santa Rosa, Cal., Aug. 16, 1938, R. H. Beamer; 5 females, 4 males, L. W. Hepner; 1 male, Dulzura, Cal., Aug. 9, 1935, R. H. Beamer; 1 female, 3 males, Lockwood, Cal., July 24, 1935, R. H. Beamer; 2 females, 1 male, Idyllwild, Cal., Aug. 3, 1935, R. H. Beamer; 17 females, 2 males, Topango Canyon, Cal., Aug. 5, 1938, R. H. Beamer, 1 female, L. W. Hepner; 12 females, 2 males, Red Bluffs, Cal., June 27, 1935, R. H. Beamer; 17 females, 8 males, Sonora, Cal., July 11, 1933, R. H. Beamer; 2 females, Redding, Cal., June 28, 1935, R. H. Beamer, 5 females, 1 male, P. W. Oman; 4 females, 2 males, Cajon Pass, Cal., Aug. 6, 1936, R. H. Beamer; 3 females, Clayton, Cal., July 29, 1935, R. H. Beamer; 2 females, Lemon Cove, Cal., July 26, 1929, R. H. Beamer; 1 female, Delta, Cal., June 28, 1935, R. H. Beamer; 1 female, Bowman, Cal., July 20, 1938, L. W. Hepner; 1 female, Alamedo county, California, July 19, 1933, Jean Russell; 2 females, Three Rivers, Cal., July 8, 1932, R. H. Beamer, 3 males, June 9, 1935, P. W. Oman; 1 male, Pasadena, Cal., July 12, 1931, E. D. Ball; 1 female, Mint Canyon,

Cal., July 7, 1933, R. H. Beamer; 7 females, Paynes Creek, Cal., June 27, 1935, P. W. Oman; 1 male, Lompoc, Cal., Aug. 6, 1938, L. W. Hepner; 1 female, Santa Cruz Mts., Cal., Aug. 13, 1938, L. W. Hepner.

Aligia occidentalis Van Duzee

(Plate XI, fig. 4)

Aligia modesta occidentalis, Van Duzee, Proc. Cal. Acad. Sci., I, p. 413, 1925.

Resembles *modesta,* but smaller, crossbands very faintly indicated and with falcate pygofer hook. Length: Male, 4.5 mm.; female, 5.25 mm.

Vertex rounded, almost parallel margined, about three times as wide between eyes as length at middle, transverse furrow almost absent. Tegmen with crossveins fairly numerous.

Color.—Vertex and scutellum ivory white to light yellow with typical markings usually lightly indicated, pronotum darker with a light median longitudinal vitta sometimes present. Tegmen semihyaline to milky, outer half with more or less hyaline areoles, veins light brown.

Genitalia.—Pygofer oval, about two-thirds as wide at constriction as length from there to apex; pygofer hook falcate, almost parallel margined on basal half, then narrowed on dorsal margin to a sharp apex. Aedeagus in lateral view slender, slightly largest at base, parallel sided and bearing a pair of lateral appendages about one-fourth as long as length of shaft of aedeagus. Styles almost three times as long as basal width, sinuately narrowed to outer sixth, apices short, dorsally curved and pointed.

Types.—Holotype female, Mus. Cal. Acad. Sci., San Francisco, Cal., allotype male, Arroyo Seco River, Cal., Aug. 8, 1938, L. W. Hepner here designated.

Material studied.—Sixty-two females, 35 males, Arroyo Seco River, Cal., Aug. 8, 1938; 14 females, 1 male, Ione, Cal., Aug. 19, 1938; 8 females, 7 males, Sonora, Cal., July 11, 1933; 33 females, 4 males, Santa Rosa, Cal., Aug. 16, 1938; 5 females, 1 male, Jamesburg, Cal., Aug. 11, 1938; 1 female, 1 male, Mt. Diablo, Cal., June 21, 1933; 33 females, 32 males, Lemon Cove, Cal., July 26, 1929, 1 female, 3 males, Aug. 10, 1938; 2 females, 3 males, Red Bluff, Cal., June 28, 1935; 9 males, Three Rivers, Cal., June 9, 1935, 8 females, 6 males, July 8, 1932; 5 males, Redding, Cal., June 28, 1935; 1 male, Los Angeles county, California; 3 males, Upper Lake, Cal., July 16, 1935; 5 females, 5 males, Winters, Cal., June 26, 1935, 3 females, Aug. 6, 1929; 1 female, 1 male, Lafayette, Cal., July 14, 1933; 1

male, Clayton, Cal., July 20, 1935; 2 females, Paynes Creek, Cal., June 27, 1935; 2 females, 2 males, Hamilton county, California, April 28, 1908; 1 female, 1 male, Bowman, Cal., Aug. 20, 1938; 2 females, 1 male, Lucerne, Cal., July 17, 1935; 1 female, Sargent, Cal., July 22, 1935; 1 female, Napa, Cal., July 26, 1935.

This species varies from almost colorless (Los Angeles county) to very dark (Monterey).

Aligia pallida Hepner

(Plate XI, fig. 5)

Aligia pallida, Hepner, L. W., Jour. of Kan. Ent. Soc. XII, p. 106, 1939.

Resembles *dellana*, but almost without darker markings and male with double pygofer hook. Length: Male, 4.5 mm.; female, 5 mm.

Vertex rounded, almost parallel margined, about three times as wide between eyes as length at middle, transverse furrow very shallow; cross veins usually few in number.

Genitalia.—Pygofer triangular, about as wide at constriction as length from there to apex; pygofer hook bifid, dorsal fork extending slightly beyond apex of pygofer, broadening to truncate apex, ventral fork almost as long, widening on outer half, usually bifid at apex. Aedeagus in lateral view about three times as long as basal width, almost parallel margined to outer fifth, widening suddenly on dorsal margin, apex triangular; in ventral view, narrow, parallel sided, bifurcate about one-fifth length of aedeagus and bearing a pair of lateral processes about one-third length of shaft of aedeagus. Styles over twice as long as basal width, sinuately narrowed to outer third with blunt apices.

Types.—Holotype male, allotype female, Santa Rita Mts., Ariz., July 17, 1932, R. H. Beamer in the Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kan. Paratypes as follows: 1 female, Santa Rita Mts., Ariz., June 12, 1932, P. W. Oman, 1 female, 1 male, June 22, 1930, E. D. Ball; 1 male, Chiricahua Mts., Ariz., July 14, 1938, R. H. Beamer, 1 female, July 5, 1930, E. D. Ball; 3 females, 1 male, Granite Dell, Ariz., July 30, 1933, R. H. Beamer, 1 female, Aug. 14, 1935, R. H. Beamer, 1 female, 1 male, May 30, 1935, P. W. Oman, 1 male, 2 females, July 17, 1929, E. D. Ball; 1 female, Tumicacari Mts., Ariz., July 22, 1938, R. H. Beamer; 1 female, Nogales, Ariz., June 25, 1933, R. H. Beamer; 1 male, Miami, Ariz., July 22, 1932, R. H. Beamer; 1 female, Tuscon, Ariz., June 9, 1929, E. D. Ball, 1 male, May 16, 1929, E. D. Ball; 1 male, Patagonia, Ariz., Sept. 7, 1929, E. D. Ball; 2 females, Huachucua Mts., Ariz., June 15, 1930, E. D. Ball.

Specimens that were collected in May and early June were much darker, with heavier and more numerous veins, evidently representing the overwintering adults.

Aligia lutea Hepner

(Plate XI, fig. 6)

Aligia lutea, Hepner, L. W., Jour. of Kan. Ent. Soc. XII, p. 106, 1939.

Resembles *pallida,* but more colorful, usually with cross veins more numerous, with aedeagus broader and bearing a pair of extremely short lateral processes, and ventral fork of pygofer hook never bifid. Length: Male, 4.5 mm.; female, 5 mm.

Vertex rounded, about two and one-half times as wide between eyes as length at middle, transverse furrow very shallow; cross veins in tegmen, although rather inconspicuous, are numerous throughout.

Color. — Tawny throughout with typical markings sometimes faintly indicated, pronotum somewhat darker. Tegmen semihyaline, more or less suffused with tawny.

Genitalia.—Pygofer triangular, about four-fifths as wide at constriction as length from there to apex; pygofer hook bifid, dorsal fork extending almost to apex, slender, widest on outer two-thirds, apex sharp; ventral fork about two-thirds as long, apex sharp. Aedeagus broad in lateral view, about twice as long as basal width, almost parallel sided and bifurcate on about outer fourth. Styles about two and one-half times basal width, sinuately narrowed to outer fifth, apices sharp.

Types.—Holotype male, allotype female, Santa Rita Mts., Ariz., July 17, 1932, R. H. Beamer in the Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kan. Paratypes as follows: 1 female, Santa Rita Mts., Ariz., June 12, 1932, P. W. Oman; 3 females, Granite Dell, Ariz., July 30, 1933, R. H. Beamer, 1 female, July 14, 1935, R. H. Beamer, 2 females, 1 male, May 30, 1935, P. W. Oman, 3 females, July 17, 1929, E. D. Ball; 1 female, Yarnell, Ariz., June 29, 1933, P. W. Oman.

As in *pallida,* specimens collected early in the year are darker and more heavily veined than others.

Aligia turbinata Ball

(Plate XI, fig. 7)

Aligia turbinata, Ball, E. D., Pan Pac. Ent. VII, p. 120, 1931.

Resembling *manitou,* but larger, much darker and with white crossband without dark markings.

Vertex about twice as wide between eyes as length at middle,

slightly pointed at apex, transverse furrow obscure. Veins in tegmen inconspicuous except on apical fourth, cross veins few in number.

Color.—Vertex black with a pair of elongate lighter basal spots, ocelli white, pronotum, scutellum and anterior half of tegmen dark reddish-brown, apical third of tegmen lighter, except for infuscated apical cells, ivory white band across second cross vein margined by fuscous.

Genitalia.—Pygofer angular, very large, about as wide at constriction as length from there to apex; pygofer hook consisting of two processes, each with a half spiral, dorsal one broader, about as long as width of pygofer at constriction; ventral, much narrower and about half as long. Aedeagus in lateral view short, about twice as long as basal width, narrowest on outer fourth, apex pointed; in ventral view, parallel sided, bifurcate on outer fourth with a pair of wide, lateral processes. Styles sinuately narrowed to a sharp apex.

Types.—Holotype female, allotype male in the E. D. Ball collection.

Material studied.—One female, Jerome, Ariz., July 30, 1933; 3 females, Miami, Ariz., July 22, 1932; 3 females, Chiricahua Mts., Ariz., July 8, 1932; 5 females, July 14, 1938; 3 females, 1 male, Yarnell, Ariz., July 25, 1932, 7 females, July 27, 1933; 1 female, Silver City, N. Mex., July 23, 1936; 2 females, Prescott, Ariz., July 29, 1933.

Specimens collected in southern Arizona and New Mexico differed from the types in having a shorter, lighter colored vertex.

Aligia chiricana alta Hepner

Aligia chiricana alta, Hepner, L. W., Jour. of Kan. Ent. Soc. XII, p. 107.

Resembling *chiricana*, but slightly larger, with a sharper vertex and with pronotum greenish-yellow; males same as females. Length: Male, 4.2 mm.; female, 5 mm.

Vertex slightly more produced at tip than *chiricana,* two and one-half times as wide between eyes as length at middle, transverse furrow shallow; cross veins in tegmen few in number, three or four in costa and one or two in center apical cell.

Genitalia.—Resembles *chiricana,* but larger, with the aedeagus slightly longer. Pygofer acute, longer than width at constriction; pygofer hook bifid, dorsal fork ending just before apex, widest at middle, tapering to a rather sharp point, ventral one about two-thirds as long, slightly more slender. Aedeagus in lateral view long and slender, narrowest on outer fourth, enlarged to about twice basal width, apex rounded; in ventral view, bifurcate on outer fourth and bearing a pair of lateral processes about one-sixth as long as shaft

of aedeagus. Styles about two and one-half times as long as basal width, sinuately narrowing to a rather blunt apex.

Types.—Holotype male, allotype female, and one female paratype, Chiricahua Mts., Ariz., July 14, 1938, R. H. Beamer in the Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kan. Additional paratypes as follows: 1 female, 1 male, Chiricahua Mts., July 14, 1938, L. W. Hepner, 1 female, 8 males, July 8, 1932, R. H. Beamer, 1 female, July 26, 1937, D. J. and J. N. Knull.

Aligia santana Ball

(Plate XI, fig. 8)

Aligia santana, Ball, E. D., Pan. Ent., VII, p. 121, 1931.

Resembles *turbinata*, but with a shorter vertex, much lighter in color, a much narrower band, white markings on tegmen next scutellum, and a much larger pygofer hook. Length: Male, 4.5 mm.; female, 5 mm.

Vertex rounded, almost parallel-sided, about four times as wide between eyes as length at middle, transverse furrow very shallow. Very few cross veins in tegmen.

Color.—Vertex and apex of scutellum ivory white, base of scutellum brown, pronotum mottled with brown. Tegmen yellowish-brown, white area along margin next scutellum, narrow white crossband just before apex of clavus, semihyaline area in region of cross nervure; at least one apical cell infuscated.

Genitalia.—Pygofer almost straight along dorsal margin, broadly curved on ventral margin, apex blunt, distinctly narrower at constriction than distance from there to apex; pygofer hook bifid, dorsal hook extending to apex of pygofer, bent into gooseneck near base, twisted just beyond, sharply pointed, ventral hook about half as long and narrower. Aedeagus similar to *turbinata*, in lateral view about twice as long as basal width, narrowest at middle, apex rounded; in ventral view parallel sided, bifurcate on outer fourth, bearing a pair of thick lateral processes. Styles more than twice as long as basal width, sinuately narrowed to a sharp apex.

Types.—Holotype female, allotype male in the E. D. Ball collection.

Material studied.—One male, 4 females, Ruby, Ariz., July 22, 1938; 3 females, Santa Rita Mts., Ariz., July 17, 1932, 1 female, 2 males, June; 1 female, Patagonia, Ariz., June 24, 1933.

Aligia modesta (Osborn and Ball)

(Plate XI, fig. 9)

Eutettix modesta, Osborn and Ball, Dav. Acad. Sci., VII, p. 98, 1898.

Resembling *manitou*, but larger, duller colored, with more rounded vertex, more cross veins in tegmen, and without any process on pygofer hook. Length: Male, 4.5 mm.; female, 5.5 mm.

Vertex rounded, almost parallel margined, about four times as wide between eyes as length at middle, transverse furrow only slightly indicated. Veins in tegmen indistinct anterior to crossband, a few cross veins in corium.

Color.—Vertex, scutellum and pronotum ivory white to light yellow with a semblance of pale markings. Tegmen of the female semihyaline to white with two tawny crossbands separated by a light band about as wide as either; males similar except that anterior band covers the entire basal half of the tegmen, apical cells partly clear.

Genitalia.—Pygofer long-ovate, less than two-thirds as wide at constriction as length from there to apex; pygofer hook slender, about one and one-fourth times length of pygofer, curved on basal third, slightly enlarged on outer fourth, tapering to sharp apex. Aedeagus in lateral view three times as long as width at base, narrowing gradually to one-half basal width just beyond middle, parallel sided to outer fifth, enlarged slightly, then rounded to apex; in ventral view, parallel sided, bifurcate on outer fifth and bearing a pair of lateral processes about one-third length of shaft of aedeagus. Styles about two and one-half times basal width, narrowed on basal third, widening at middle, dorsal margin suddenly narrowing to one-fifth basal width, outer fourth with sides parallel, curved dorsally with sharp apex.

Types.—Holotype male allotype female at Iowa State College, Ames, Iowa.

Material studied.—One male, Douglas county, Kansas, July 31, 1930, P. B. Lawson, collected at light. Other material from Kansas may be *modesta*, but lack of male specimens make it impossible to definitely determine them as such.

Aligia meridiana Hepner

(Plate XI, fig. 10)

Aligia meridiana, Hepner, L. W., Jour. of Kan. Ent. Soc., XII, p. 108.

Similar to *modesta*, but more highly colored and with the male pygofer truncate at apex. Length: Male, 4.5 mm.; female, 5.5 mm.

Vertex rounded, almost parallel margined, about three times as wide between eyes as length at middle, transverse furrow shallow.

Veins in tegmen distinct on outer half, cross veins fairly numerous in corium.

Color.—Vertex, pronotum and scutellum yellow-brown to orange, indications of typical markings usually present, face and clypeus yellow, sometimes with indications of dashes on clypeus. Tegmen of the female semihyaline to white, with two reddish-brown crossbands separated by a light band about as wide as either, males similar, except that anterior band covers entire basal half of tegmen, veins of both always tawny, apical cells more or less infuscated.

Genitalia.—Pygofer broad, wider on outer third than at constriction; pygofer hook extending beyond apex of pygofer, widest at base, almost parallel margined on outer three-fourths, apex sharp. Aedeagus broad in lateral view, a little more than twice as long as basal width, slightly narrowed from base to rounded apex; in ventral view, parallel sided, bifurcate on outer fifth and bearing a pair of lateral processes about one-half as long as shaft. Styles about three times as long as basal width, narrowed gradually to one-half basal width at middle, then both sides converging near outer sixth to about one-sixth basal width, apices strongly curved dorsally.

Types.—Holotype male, allotype female, Fulton, Miss., July 14, 1930, L. D. Tuthill in Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kan. Paratypes as follows: 1 female, Meridian, Miss., July 17, 1930, P. W. Oman; 2 males, Fulton, Miss., July 14, 1930, R. H. Beamer; 1 male, Iuka, Miss., July 14, 1930, R. H. Beamer; 2 males, Jefferson, Texas, June 21, 1938, R. H. Beamer; 1 male, Leavenworth, Kan., June 30, 1924, E. P. Breakey; 3 males, Coffeyville, Kan., June 30, 1939, L. W. Hepner, 1 female, 7 males, July 1, 1939; 1 female, 7 males, July 4, 1939; 7 females, 3 males, July 11, 1939; 8 females, 2 males, July 16, 1939; 13 females, July 21, 1939 and 1 female, July 25, 1939 all collected at Coffeyville, Kan., by L. W. Hepner.

Aligia bifurcata Hepner

(Plate XII, fig. 11)

Aligia bifurcata, Hepner, L. W., Jour. of Kan. Ent. Soc., XII, p. 108, 1939.

Resembles *magna*, but smaller, tawny and without a semblance of a crossband. Length: Male, 5 mm.; female, 5.5 mm.

Vertex almost parallel margined, three to four times as wide between eyes as length at middle, transverse furrow shallow; numerous cross veins throughout tegmen.

Color.—Vertex and scutellum ivory yellow to light brown with typical markings somewhat darker, pronotum more or less irrorate

with dark. Tegmen semihyaline to white, more or less suffused with tawny, veins darker, apical cells partly infuscated.

Genitalia.—Pygofer more or less oval, about one and one-fourth times as long as width at constriction; pygofer hook bifid, dorsal fork extending slightly beyond apex of pygofer, apex pointed, ventral fork about two-thirds length of dorsal, one-third wider, widest on outer third, apex pointed. Aedeagus in lateral view broad, about twice as long as basal width, sides almost parallel, narrowest on outer third, a pair of dorsal teeth just beyond, apex angular; in ventral view, bifurcate on outer third and bearing a pair of short lateral processes. Styles about twice as long as basal width, sinuately narrowed to outer sixth, apices sharp and curved.

Types.—Holotype male, Huachucua Mts., Ariz., June 11, 1933, P. W. Oman in the National Museum, Washington, D. C.; allotype female, Chiricahua Mts., Ariz., July 14, 1938, R. H. Beamer in the Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kan. Paratypes as follows: 3 females, Chiricahua Mts., Ariz., July 14, 1938, R. H. Beamer; 1 female, Huachucua Mts., Ariz., July 8, 1932, R. H. Beamer; 2 females, Glenn Oaks, Ariz., July 19, 1929, E. D. Ball.

Aligia acutata Hepner

(Plate XII, fig. 12)

Aligia acutata, Hepner, L. W., Jour. of Kan. Ent. Soc., XII, p. 109, 1939.

Resembles *magna*, but smaller and more slender with a slender aedeagus without lateral processes and with forks of pygofer hook slender. Length: Male, 5 mm.; female, 6 mm.

Vertex produced, about two and one-half times as wide between eyes as length at middle, transverse furrow prominent. Tegmen long with many cross veins throughout.

Color.—Vertex ivory yellow with two pairs of dark dots along anterior margin, a dark line along transverse furrow and a pair of lighter dots inside each eye. Pronotum grey flecked with fuscous except for a median longitudinal vitta and oftentimes a similar vitta on each side. Scutellum ivory yellow to light brown with typical markings darker. Tegmen semihyaline to white without any indication of a crossband, apical cells mostly fumose.

Genitalia.—Pygofer acutely pointed at apex, broadly rounding on ventral margin, three-fourths as wide as constriction as length from there to apex; pygofer hook bifid, dorsal fork somewhat longer than pygofer, broadest at middle, apex sharp, ventral fork almost half as long as dorsal, very slender and almost parallel margined to sharp

apex. Aedeagus in lateral view about five times basal width, slightly enlarged on dorsal margin near middle, dorsal teeth prominent, apex oval; in ventral view parallel sided and bifurcate on outer fifth. Styles slender, somewhat over twice as long as basal width, sinuately narrowed to outer fourth, apices long, slender and sharply pointed.

Types.—Holotype male, allotype female and six female and two male paratypes, Huachucua Mts., Ariz., July 18, 1938, R. H. Beamer in the Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kan. Additional paratypes as follows: 2 females, 1 male, Huachucua Mts., Ariz., Aug. 22, 1935, R. H. Beamer; 2 females, 2 males, Oct. 31, 1937, P. W. Oman; 1 female, Aug. 2, 1927, R. H. Beamer; 5 females, 3 males, Chiricahua Mts., Ariz., July 14, 1938, R. H. Beamer; 2 females, 1 male, July 8, 1932. R. H. Beamer; 1 male, July 8, 1932, J. D. Beamer; 1 male, July 5, 1930, E. D. Ball; 1 female July 14, 1938, L. W. Hepner; 1 male, June 9, 1933, R. H. Beamer; 2 females, Chiricahua National Monument, Ariz., Aug. 24, 1935, Jean Russell; 1 female, R. H. Beamer; 1 male, Santa Rita Mts., Ariz., July 17, 1932, R. H. Beamer; 1 female, 2 males, June 16, 1936, P. W. Oman; 1 female, 6 males, June 22, 1930, E. D. Ball; 2 females, Aug. 18, 1935, R. H. Beamer; 2 males, Tuscon, Ariz., Sept. 29, 1929, E. D. Ball; 1 male, Sept. 1, 1929, E. D. Ball; 1 female, 1 male, June 30, 1929, E. D. Ball.

Aligia colei Van Duzee

(Plate XII, fig. 13)

Aligia colei, Van Duzee, Proc. Cal. Acad. Sci., XIV, p. 412, 1925.

Resembles *inscripta,* but with sharper vertex and crossbands indistinct or absent. Length: Male, 5 mm.; female, 6 mm.

Vertex about one and one-half times as wide between eyes as length at middle, produced to a sharp point, transverse furrow shallow; twelve to sixteen cross veins more or less evenly spaced along costae and numerous other cross veins throughout tegmen.

Color.—Vertex, scutellum and anterior margin of pronotum brown, typical markings sometimes present, but usually light and indistinct. Posterior part of pronotum dark gray, more or less mottled with brown, an indication of a pair of median longitudinal brown vittae. Tegmen semihyaline with heavy fuscous veins, point at apex of clavus, black, crossbands absent, tegmen evenly inscribed with fuscous.

Genitalia.—Pygofer almost triangular, about two-thirds as wide at constriction as length from there to apex, dorsal margin folded;

pygofer hook bifid, dorsal fork about twice as long as ventral, almost parallel with it on outer two-thirds, slightly wider throughout. Aedeagus in lateral view one-third as wide at base as length, narrowed on outer one-third to one-half basal width, widened suddenly, then narrowed to sharp apex; in ventral view, narrow, parallel sided, apex bifurcate one-third length of shaft. Styles about twice as long as basal width, gradually narrowed to one-fourth basal width on outer fourth, apices blunt.

Types.—Holotype male, allotype female, Mus. Cal. Acad. Sci., San Francisco, Cal.

Material studied.—Nineteen females, 51 males, Towie, Cal., Aug. 20, 1938; 7 females, 3 males, Santa Cruz Mts., Cal., Aug. 14, 1938; 1 male, Giant Forest, Cal., July 28, 1929; 18 females, 9 males, San Jacinto Mts., Cal., July 21, 1929; 1 male, San Diego Co., Cal., July 4, 1929; 4 females, 2 males, Santa Rosa, Cal., Aug. 16, 1938; 1 female, Lucerne, Cal., July 17, 1935; 2 females, Anza, Cal., July 29, 1938; 1 male, Occidental, Cal., August 16, 1938; 2 females, Ione, Cal., Aug. 19, 1938; 1 female, Davenport, Cal., July 13, 1938; 1 female, 1 male, Jamesburg, Cal., Aug. 11, 1938; 1 female, Monterey, Cal., Aug. 10, 1938; 1 female, 1 male, Truckee, Cal., Aug. 20, 1938; 2 females, Idyllwild, Cal., Aug. 3, 1935.

The specimens collected in the southern part of the state, near the type locality, were more strongly marked than those collected farther north.

Aligia californica Van Duzee

(Plate XII, fig. 14)

Aligia californica, Van Duzee, Proc. Cal. Acad. Sci., p. 411, 1925.

Similar to *jucunda*, but larger, darker and without a semblance of a crossband. Length: Male, 5 mm.; female, 6 mm.

Vertex angled, distinctly wider than length at middle, transverse furrow prominent; tegmen with numerous cross veins.

Color.—Vertex and scutellum ivory white to yellow, with markings usually fuscous and distinct; pronotum grey, more or less mottled with fuscous, except an indication of a median longitudinal vitta; three pairs of dark spots along anterior margin usually distinct. Tegmen semihyaline to milky, usually with fuscous veins and no indication of a crossband, apical cells partly fumose.

Genitalia.—Pygofer rounded on ventral margin, pointed at apex, about three-fourths as wide at constriction as distance from there to apex; pygofer hook falcate, almost parallel sided on basal half, then tapering gradually to a sharp point. Aedeagus in lateral view short

and broad, about three and one-half times as long as basal width, almost parallel margined to outer third, then slightly enlarged on ventral margin, apex rounded; in ventral view parallel sided and bearing a pair of lateral processes about one-fourth length of shaft of aedeagus. Styles about two and one-half times as long as basal width, sinuately narrowed to one-fifth basal width on outer fifth, apices truncate.

Types.—Holotype female, allotype male in Mus. Cal. Acad. Sci., San Francisco, Cal.

Material studied.—Fifteen females, 12 males, Anza, Cal., July 29, 1938; 10 females, 12 males, San Jacinto Mts., Cal., July 29, 1928; 2 females, 2 males, Big Bear Lake, Cal., July 26, 1932; 1 female, Delta, Cal., June 28, 1935; 1 female, Lake Tahoe, Cal., Sept. 13, 1915; 1 female, Claremont, Cal., July 29, 1935; 1 female, 1 male, Atascadero, Cal., July 19, 1933; 1 female, Idyllwild, Cal., Aug. 3, 1935; 1 male, San Antonio Canyon, Cal., Aug. 4, 1938; 1 female, Delta, Cal., June 28, 1935; 2 females, Alpine, Cal., July 9, 1929; 16 females, 4 males, Lompoc, Cal., Aug. 9, 1938; 12 females, Santa Cruz Mts., Cal., Aug. 13, 1938; 1 female, 1 male, Elsinor, Cal., Aug. 3, 1935; 13 females, 2 males, Towie, Cal., Aug. 20, 1938; 5 females, 2 males, Pine Valley, Cal., July 27, 1938; 1 male, Truckee, Cal., Aug. 20, 1938; 1 female, 1 male, Santa Rosa, Cal., Aug. 16, 1938; 2 females, 1 male, Medford, Ore., June 26, 1934; 1 male, Grant's Pass, Ore., July 13, 1935; 2 females, Nevada, March, 1936.

Aligia inscripta (Van Duzee)

(Plate XII, fig. 15)

Allygus inscriptus, Van Duzee, Ent. Am., p. 92, 1890.

Resembles *colei,* but with shorter vertex, banded tegmen, aedeagus longer and more slender, and with pygofer more oval. Length: Male, 4.75 mm.; female, 5.25 mm.

Vertex twice as wide between eyes as length at middle, almost a right angle, apex sharp, transverse furrow shallow; numerous cross veins on costa, in middle anteapical cells and on corium next claval suture.

Color.—Vertex and scutellum pale lemon to brown, typical markings usually present; eyes usually red; pronotum dark fuscous more or less mottled with gray, an indication of a median longitudinal lighter vitta. Tegmen semihyaline to white with two fuscous crossbands, light area between about half as wide as either, apical cells usually partly infuscated.

Genitalia.—Pygofer about as wide at constriction as length from there to apex, dorsal margin folded, apex bluntly pointed; pygofer hook bifid, dorsal fork about one and one-half times as long as ventral, almost parallel with it on outer two-thirds, dorsal fork slightly more slender and more sharply pointed. Length of shaft of aedeagus in lateral view about four times basal width, curved dorsally, narrowed gradually to one-half basal width at outer fourth, broadening slightly and tapering to a blunt point; in ventral view, narrow, parallel sided, apex bifurcate one-fourth length of shaft. Styles more than twice as long as basal width, narrowing gradually to one-half basal width, converging suddenly to one-fifth basal width on outer fourth, apices slender, curved and bluntly pointed.

Types.—Holotype male, Iowa State College, Ames, Iowa, allotype female, Cajon Pass, Cal., July 6, 1936, R. H. Beamer here designated.

Material studied.—7 females, 6 males, Jamesburg, Cal., Aug. 11, 1938; 5 females, 8 males, Santa Rosa, Cal., Aug. 16, 1938; 6 females, 13 males, Arroyo Seco River, Cal., Aug. 8, 1938; 5 females, 1 male, Lockwood, Cal., June 24, 1935; 5 females, 2 males, Pine Valley, Cal., July 25, 1938; 7 females, 3 males, Mountain Springs, Cal., July 25, 1938; 4 females, 2 males, Cajon Pass, Cal., Aug. 6, 1936; 1 female, Monterey, Cal., July 22, 1935, 1 female, Aug. 10, 1938; 3 females, 1 male, Lompoc, Cal., Aug. 6, 1938; 5 females, Santa Cruz Mts., Cal., Aug. 13, 1938; 1 female, 3 males, Mint Canyon, Cal., July 6, 1933; 1 female, Big Bear Lake, Cal., July 26, 1932; 2 females, Upper Lake Cal., July 16, 1935; 1 female, Clayton, Cal., July 20, 1935; 1 female, Anza, Cal., July 6, 1935; 1 female, Beaumont, Cal., July 20, 1935; 1 male, Atascadero, Cal., July 19, 1933; 1 male, Campo, Cal., Aug. 10, 1933; 1 female, San Jacinto Mts., Cal., June 30, 1933; 1 female, Idyllwild, Cal., Aug. 3, 1935; 6 females, 2 males, Topango Canyon, Cal., Aug. 5, 1938; 1 female, 1 male, Dulzura, Cal., Aug. 9, 1935.

Aligia pallidinota Hepner

(Plate XII, fig. 16)

Aligia pallidinota, Hepner, L. W., Jour. of Kan. Ent. Soc. XII, p. 110, 1939.

Resembles *inscripta*, but with vertex, pronotum and scutellum light colored. Length: Male, 5 mm.; female, 5.5 mm.

Vertex twice as wide between eyes as length at middle, produced in a right angle to a more or less sharp tip, transverse furrow shallow. Veins in tegmen numerous on costa, in middle anteapical cells and on corium next clavus.

Color.—Vertex and scutellum ivory white, a semblance of markings sometimes present; pronotum more or less mottled with gray,

an indication of a pair of median longitudinal darker vittae; face, clypeus and margins of lorae fuscous, darker than *inscripta*. Tegmen semihyaline to white with two fuscous crossbands, light area between about half as wide as either, apical cells at least partly infuscated.

Genitalia.—Pygofer more rounded than in *inscripta*, with apex blunter and fold along dorsal margin narrower; pygofer hook bifid, dorsal fork about twice as long as ventral, almost parallel with it on outer two-thirds, both about same width throughout. Aedeagus in lateral view about three times as long as basal width, narrowed evenly to one-third basal width just beyond middle, suddenly broadening to one-half basal width and tapering to blunt point; in ventral view, narrow, parallel sided, apex bifurcate one-third length of shaft of aedeagus. Styles more than twice as long as width at base, gradually narrowing to slightly over one-half basal width, constricting suddenly to one-fifth basal width, ventral margins curved to sharp apex.

Types.—Holotype male, allotype female and two female paratypes, Lompoc, Cal., Aug. 9, 1938, R. H. Beamer in the Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kan. Additional paratypes as follows: 4 females, 1 male, Lompoc, Cal., Aug. 9, 1938, L. W. Hepner, 1 female, 3 males, R. I. Sailer; 2 females, 1 male, Dulzura, Cal., Aug. 9, 1935, R. H. Beamer.

The specimens from Dulzura are much lighter than those from the type locality, the dark areas of the tegmen being replaced by pale brown and the markings on the vertex being hardly visible.

Aligia obesa Hepner

(Plate XII, fig. 17)

Aligia obesa, Hepner, L. W., Jour. of Kan. Ent. Soc., XII, p. 110, 1939.

Resembles *bifasciata*, but smaller with a shallower transverse furrow and with tegmen decidedly narrower at apex. Length: Male, 4 mm.; female, 5 mm.

Vertex round, almost parallel margined, about four times as wide between eyes as length at middle, transverse furrow shallow. Tegmen less flaring than either *munda* or *bifasciata*, distinctly narrower from tip of clavus to apex and closely appressed, giving the species a very narrow appearance posteriorly, cross veins numerous throughout.

Color.—Eyes red, vertex and scutellum ivory white to very pale brown, typical markings usually present, but light, pronotum more or less mottled with fuscous. Tegmen semihyaline to white with two

brown crossbands, light area between about half as wide as either, veins brown, apical cells at least partly infuscated.

Genitalia.—Pygofer oval, apex broadly rounded, about as wide at constriction as distance from there to apex; pygofer hook bifid, forks about equal in length, dorsal one about twice width of ventral, forks almost parallel along most of their length. Aedeagus in lateral view between four and five times as long as basal width, narrowing gradually to one-half basal width at middle, slightly enlarged on dorsal margin just before bluntly pointed apex. Styles twice as long as basal width, slightly narrowed at middle, three-fourths basal width near outer fourth, suddenly narrowed to one-sixth basal width, fingerlike process of apex parallel sided and curved.

Types.—Holotype male, allotype female, Ozona, Tex., July 9, 1936, R. H. Beamer in the Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kan. Paratypes as follows: 1 female, Tucumcari, N. Mex., June 25, 1932; R. H. Beamer; 2 females, Concan, Texas, June 4, 1933, P. W. Oman.

Aligia rotunda Hepner

(Plate XII, fig. 18)

Aligia rotunda, Hepner, L. W., Jour. of Kan. Ent. Soc., XII, p. 111, 1939.

Resembles *bifasciata,* but smaller with ventral fork of pygofer hook not greatly enlarged at base. Tegmen not narrowed at apex as in *obesa.* Length: Male, 4 mm.; female, 5 mm.

Vertex almost parallel margined, decidedly wider between eyes than length at middle, transverse furrow prominent. Venation as in *bifasciata,* with many cross veins.

Color.—Eyes red, vertex and scutellum dull yellow with typical markings fulvous, pronotum darker, more or less marked with fuscous. Tegmen semihyaline to white with two dark bands, one anterior and one posterior to second cross nervure, veins dark, apical cells partly infuscated.

Genitalia.—Pygofer almost round, slightly longer than width at constriction; pygofer hook bifid, forks about equal in length, extending to margin of pygofer with dorsal one about half as thick as ventral. Aedeagus in lateral view long, narrowest at middle, widest at base and on apical fourth, apex rather sharp. Styles more than twice as long as basal width, sinuately narrowing to outer fourth, apices curved and bluntly pointed.

Types.—Holotype male, allotype female and one female paratype, Tombstone, Ariz., July 16, 1936, E. D. Ball in the E. D. Ball collec-

tion. Additional paratypes as follows: 2 males, Tombstone, Ariz., June 8, E. D. Ball.

This species might be confused with *oculea*, but has a great many more cross veins and differs greatly in the internal genitalia.

Aligia bifasciata Hepner

(Plate XII, fig. 19)

Aligia bifasciata, Hepner, L. W., Jour. of Kan. Ent. Soc., XII, p. 112, 1939.

Resembles *munda*, but slightly smaller, darker, with a shorter vertex and aedeagus in lateral view widest beyond middle. Length: Male, 4.75 mm.; female, 5.5 mm.

Vertex almost parallel margined, about four times as wide between eyes as length at middle, transverse furrow prominent. Numerous cross veins throughout tegmen as in *munda*.

Color.—Vertex light brown, a pair of black dots at apex, another pair near ocelli, a much lighter pair just inside each eye, transverse furrow dark. Pronotum irrorate with fuscous, a pale longitudinal median line indicated. Scutellum light, except a large spot in each basal angle, a pair of small dots between these, a transverse line near apex, and a median line, darker. Tegmen semihyaline to white with two fuscous crossbands, light area between about half as wide as either; apical cells at least partly infuscated.

Genitalia.—Pygofer rounded, slightly longer than width at constriction, folded along ventral margin; pygofer hook bifid, forks almost equal in length, dorsal one more slender, ventral one enlarged on basal two-fifths. Aedeagus in lateral view very long, eight times basal width, narrowest next base, widest near outer third, narrowing gradually to blunt apex. Styles more than twice as long as width at base, narrowing gradually to one-half width at middle, slightly enlarged on outer fifth, converging suddenly to slender, curved pointed apices.

Types.—Holotype male, allotype female and 1 pair of paratypes, Chiricahua Mts., Ariz., July 14, 1938, R. H. Beamer in the Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kan. Additional paratypes as follows: 1 female, Ruby, Ariz., July 22, 1938, R. H. Beamer; 1 female, Santa Rita Mts., Ariz., Aug. 18, 1935, R. H. Beamer, 1 male, June 27, 1933, P. W. Oman, 1 female, June 16, 1933, P. W. Oman, 1 female, June 12, 1933, P. W. Oman, 2 males, Tuscon, Ariz., Oct. 20, 1929, E. D. Ball.

Aligia descripta Ball

(Plate XII, fig. 20)

Aligia descripta, Ball, E. D., Pan. Pac. Ent., VII, p. 119, 1931.

Resembles *munda*, but darker, smaller and with a sharper vertex. Length: Males, 4.5 mm.; females, 5 mm.

Vertex produced to almost a right angle, about twice as wide between eyes as length at middle, especially the female, apex sharp, transverse furrow definite. Numerous cross veins throughout tegmen as in *munda*.

Color.—Vertex and scutellum ivory white to yellow, typical markings usually distinct; pronotum gray, more or less irrorate with fuscous; clypeus, cheeks and markins of lorae fuscous, excepting four or five light dashes on clypeus. Tegmen semihyaline to white, faint indication of the usual crossband sometimes present.

Genitalia.—Pygofer beyond constriction triangular, apex rounded, slightly narrower at constriction than distance from there to apex; pygofer hook bifid, each fork about as long as width of pygofer, forks almost parallel for most of their length, ventral slightly thicker. Aedeagus in lateral view about four times as long as basal width, narrowest at middle, almost parallel margined from there to bluntly pointed apex; in dorsal view, narrow and parallel sided. Styles about three times as long as basal width, almost parallel margined to outer fifth, converging suddenly to one-fifth basal width, apices sharply curved and very bluntly pointed.

Types.—Holotype female, allotype male in the E. D. Ball collection.

Material studied.—Two females, 1 male, Prescott, Ariz., Aug. 7, 1932, 1 male, July 29, 1933; 2 females, 5 males, Yarnell, Ariz., July 25, 1932, 7 females, 1 male, June 29, 1933; 1 female, Granite Dell, Ariz., July 30, 1933, 1 female, Aug. 14, 1936, 5 females, May 30, 1935, 1 female, June 29, 1933; 1 female, Gila county, Arizona, Aug. 5, 1927; 1 female, 2 males, Miami, Ariz., July 22, 1932; 1 male, Oak Creek Canyon, Ariz., July 31, 1933; 1 female, Ashfork, Ariz., Aug. 8, 1932; 1 female, Santa Rita Mts., Ariz., Aug. 18, 1935, 2 females, 2 males, July 17, 1935; 1 female, Zion National Park, Utah, Aug. 13, 1929.

Aligia reticulata Hepner

(Plate VIII, fig. 21)

Aligia reticulata, Hepner, L. W., Jour. of Kan. Ent. Soc., XII, p. 112, 1939.

Resembles *descripta*, but with margins of vertex almost parallel, aedeagus short and wide in lateral view, and dorsal fork of pygofer hook broad at apex. Length: Male, 4.2 mm.; female, 5 mm.

Vertex almost parallel margined, about three times as wide between eyes as length at middle, transverse furrow prominent. Cross veins numerous throughout tegmen.

Color.—Clypeus, anteclypeus, lorae and cheeks ivory yellow with few brown markings, vertex ivory yellow with typical markings fuscous, pronotum more or less mottled with fuscous, scutellum light with apex and basal angles darker. Tegmen semihyaline to white, with sometimes a faint indication of crossband, veins dark, apical cells often slightly infuscated.

Genitalia.—Pygofer oval, somewhat narrower at constriction than distance from there to apex; pygofer hook bifid, dorsal fork extending slightly beyond apex of pygofer, broadening on outer two-thirds to truncate apex; ventral fork short and about as wide as narrowest point of dorsal. Aedeagus in lateral view broad and short, about twice as long as basal width, broadest at base, tapering from there to a pair of short teeth on dorsal margin one-fourth distance from tip, apex triangular; in ventral view, bifurcate on outer fourth and bearing a pair of short lateral processes. Styles about twice as long as basal width, sinuately converging from base, apex sharp.

Types.—Holotype male, allotype female, and one pair of paratypes, Miami, Ariz., July 22, 1932, R. H. Beamer in the Francis Huntington Snow Museum, University of Kansas, Lawrence, Kan. Additional paratypes as follows: 2 females, 1 male, Yarnell Heights, Ariz., June 29, 1933, P. W. Oman; 1 female, Yavapai county, Ariz., July 1, 1929, R. H. Beamer; 1 female, Granite Dell, Ariz., July 30, 1933, R. H. Beamer; 2 females, Nogales, Ariz., July 25, 1933, R. H. Beamer; 2 females, Santa Rita Mts., Ariz., July, F. H. Snow, 1 female, May 30, 1930, E. D. Ball; 1 female, Tuscon, Ariz., June 16, 1933, 1 female, Oct. 20, 1929, E. D. Ball, 1 female, May 16, 1929, E. D. Ball.

Aligia atrivena Hepner

(Plate XIII, fig. 22)

Aligia atrivena, Hepner, L. W., Jour. of Kan. Ent. Soc. XII, p. 113, 1939.

Resembles *jucunda,* but larger, darker and with more reticulations in tegmen. Length: Male, 5 mm.; female, 5.75 mm.

Vertex slightly produced, about three and one-half times as wide between eyes as length at middle, transverse furrow prominent.

Color.—Vertex and scutellum ivory white to light yellow, with typical markings dark and distinct; pronotum gray more or less irrorate with fuscous with three pairs of dark spots along the anterior margin distinct. Tegmen semihyaline to white with veins fus-

cous, faint indication of crossbands sometimes present, apical cells partly infuscated.

Genitalia.—Pygofer slender, rounded at apex, about one and one-fourth times as long as width at constriction; pygofer hook falcate, bent into right angle near base, distinctly widest near outer third, tapering to long sharp point. Aedeagus in lateral view long, bent dorsally in a right angle near base, sides parallel to outer fourth, abruptly enlarged to large knoblike apex; in ventral view parallel margined, bifurcate on outer fifth and bearing a pair of lateral appendages about one-fifth as long as length of shaft. Styles about twice basal width, sinuately narrowed to outer fifth, apices curved and pointed.

Types.—Holotype male, allotype female and 2 male paratypes, Yarnell, Ariz., July 29, 1933, R. H. Beamer in the Francis Huntington Snow Museum, University of Kansas, Lawrence, Kan. Additional paratypes as follows: 3 females, 3 males, July 25, 1932, R. H. Beamer, 15 females, 5 males, June 29, 1933, P. W. Oman; 1 female, 1 male, Yavapai Co., Ariz., Aug. 9, 1927, R. H. Beamer; 1 female, Colfax county, New Mexico, Aug. 21, 1927, R. H. Beamer; 1 female, Luna, N. Mex., July 25, 1936, R. H. Beamer; 1 female, Silver City, N. Mex., July 22, 1936, D. R. Lindsay, 1 female, July 23, 1936, R. H. Beamer; 1 male, Cloudcroft, N. Mex., June 30, 1932, R. H. Beamer; 1 male, Durango, Colo., July 6, 1937, R. H. Beamer; 2 males, Granite Dell, Ariz., May 30, 1935, P. W. Oman; 2 females, 3 males, Mayhill, N. Mex., June 7, 1933, P. W. Oman.

Aligia magna Hepner

(Plate XIII, fig. 23)

Aligia magna, Hepner, L. W., Jour. of Kan. Ent. Soc., XII, p. 114, 1939.

Resembles *munda,* but slightly larger, darker and with a less angular vertex and with ventral fork of pygofer hook much enlarged on outer third; aedeagus with lateral processes. Length: Male, 4.2 mm.; female, 5 mm.

Vertex slightly angled, about two and one-half times as wide between eyes as length at middle, transverse furrow prominent; tegmen long, broadest on basal fifth, many cross veins throughout.

Color.—Vertex and scutellum ivory to white with typical markings fulvous, pronotum more or less irrorate with fuscous. Tegmen semihyaline to white with fuscous markings darker, crossbands usually faintly evident, veins dark.

Genitalia.—Pygofer triangular, broadly rounded on ventral mar-

gin, almost as wide at constriction as distance from there to apex; pygofer hook bifid, dorsal fork extending about to apex of pygofer, broadest on apical half, irregularly notched on ventral margin and sharply pointed, ventral fork slightly over one-half as long, enlarged to twice basal width on outer fourth. Aedeagus in lateral view slender, about three times as long as basal width, narrowest on outer fourth, apical dorsal teeth about as long as width of shaft at narrowest point, apex oval; in ventral view slender, parallel margined, bifurcate on outer fourth and bearing a pair of short, erect processes one-third length of shaft of aedeagus from apex. Styles about twice as long as basal width, sinuately narrowed to a typical apex.

Types.—Holotype male, allotype female and 20 female and 6 male paratypes, Huachucua Mts., Ariz., July 18, 1938, R. H. Beamer in the Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kan. Additional paratypes as follows: 2 females, Huachucua Mts., Ariz., Aug. 22, 1935, R. H. Beamer; 2 females, June 11, 1933, R. H. Beamer, 4 females, Oct., 30, 1937, P. W. Oman, 2 males, June 15, 1930, E. D. Ball, 2 females, Aug. 2, 1931, E. D. Ball; 15 females, Chiricahua National Monument, Aug. 24, 1935, R. H. Beamer, 7 females, Jack Beamer, 5 females, Jean Russell; 2 females, 1 male, Chiricahua Mts., Ariz., July 14, 1938, R. H. Beamer, 1 male, July 14, 1938, R. I. Sailer, 1 male, July 8, 1932, J. D. Beamer.

Aligia munda (Ball)

(Plate XIII, fig. 24)

Eutettix munda, Ball, E. D., Can. Ent., XXXIII, p. 48, 1901.

Resembling *descripta*, but much larger, darker and with a blunter vertex. Length: Male, 5 mm.; female, 6 mm.

Vertex about two and one-half times as wide between eyes as length at middle, slightly angled with apex rounded, transverse furrow moderately shallow; numerous cross veins throughout tegmen.

Color.—Vertex, scutellum and anterior part of pronotum light fulvous with typical markings usually brown and distinct, posterior part of pronotum gray, more or less mottled with fuscous, an indication of a pair of median longitudinal darker vittae. Face, cheeks and lorae light. Tegmen semihyaline to white, veins dark.

Genitalia.—Pygofer oval, about two-thirds as wide at constriction as distance from there to apex, which is broadly rounded; pygofer hook bifid, dorsal fork slightly longer than ventral, usually slightly diverging and about one-half as thick as ventral throughout. Aede-

agus in lateral view curved dorsally, four times as long as basal width, gradually narrowing to one-half basal width at middle, distal half almost parallel sided to bluntly pointed apex; in dorsal view narrow and parallel sided. Styles almost three times as long as basal width, nearly parallel margined to outer fifth, converging suddenly to one-fourth basal width, apices sharply curved and pointed.

Types.—Holotype female in the E. D. Ball collection, allotype male, Durango, Colo., June 6, 1937, R. H. Beamer in the Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kan.

Material studied.—One female, Sloss, Colo., Aug. 17, 1929; 1 male, Durango, Colo., July 6, 1937; 1 female, Alton Utah, Aug. 11, 1936; 1 female, Cedar City, Utah, Aug. 13, 1929; 1 female, 1 male, Weber Canyon, Utah, July 4, 1931; 1 male, Granite, Utah, June 24, 1936; 1 female, 1 male, Cloudcroft, N. Mex., June 7, 1933, 1 female, June 28, 1933; 6 females, 2 males, Mayhill, N. Mex., June 7, 1933; 1 female, Cowles, N. Mex., July 18, 1936, 1 male, Glenn Oaks, Ariz., July 18, 1929, 1 female, Aug. 14, 1927; 1 female, Richfield, Utah, Willow Patch, Sept. 2, 1930; 1 female, Oak Creek Canyon, Ariz., Aug. 14, 1927.

Aligia obtusa Hepner

(Plate XIII, fig. 25)

Aligia obtusa, Hepner, L. W., Jour. of Kan. Ent. Soc., II, p. 114, 1939.

Resembling *jucunda*, but slightly larger, darker, with a broader, shorter vertex and with pygofer hook much broader on outer half. Length: Male, 4.5 mm.; female, 5.25 mm.

Vertex rounded, parallel margined, about four times as wide between eyes as length at middle, transverse furrow very shallow. Tegmen less flaring than normal with a moderate number of cross veins.

Color.—Vertex and scutellum ivory white to light yellow with typical markings light brown. Pronotum gray, more or less flecked with fuscous. Tegmen semihyaline to white marked with fuscous, faint semblance of crossbanding usually evident, veins dark, apical cells partly infuscated.

Genitalia.—Pygofer broad, bluntly pointed, about as wide at constriction as distance from there to apex; pygofer hook extending to margin of pygofer, bent into gooseneck near base, broadening to over twice narrowest width near middle, then narrowing to a sharp apex. Aedeagus in lateral view short, about two and one-half times basal width, narrowest on outer third, dorsal teeth small and pointed, in ventral view, broadening toward apex, bifurcate on outer third and

bearing a pair of lateral processes almost one-third length of shaft of aedeagus. Styles about twice basal width, sinuately narrowed to outer fifth, apices slender and bluntly pointed.

Types.—Holotype male, allotype female and 3 male paratypes Granite Dell, Ariz., May 30, 1935, P. W. Oman in the National Museum, Washington, D. C. Additional paratypes as follows: 1 female, Huachucua Mts., Ariz., June 11, 1933, R. H. Beamer.

Aligia falcata Hepner

(Plate XIII, fig. 26)

Aligia falcata, Hepner, L. W., Jour. of Kan. Ent. Soc., XII, p. 115, 1939.

Resembles *munda*, but with more rounded vertex, less cross veins in tegmen and pygofer hook falcate. Length: Male, 5.25 mm.; female, 6.25 mm.

Vertex rounded, almost parallel margined, about four times as wide between eyes as length at middle, transverse furrow almost absent; few cross veins in tegmen, except in corium next clavus and in middle anteapical cell.

Color.—Vertex and scutellum ivory white to light yellow with markings indistinct except large brown spot in each basal angle of scutellum; pronotum grey to yellow, more or less irrorate with brown. Tegmen semihyaline to white with two indistinct fuscous bands separated by a light area about as wide as either, apex more or less infuscated.

Genitalia.—Pygofer slender, about one and one-half times as long as width at constriction; pygofer hook falcate, almost parallel margined to outer fourth, then narrowed on dorsal margin to sharp apex. Aedeagus in lateral view slender, about twice as long as basal width, almost parallel margined to outer fourth, apex rounded; in ventral view parallel margined, bifurcate on outer fourth, and bearing a pair of lateral processes about as long as one-fourth length of shaft of aedeagus. Styles about twice basal width in length, sinuately narrowing to outer fifth, apices curved and pointed.

Types.—Holotype male, allotype and 2 male paratypes, Oak Creek Canyon, Ariz., Aug. 14, 1927, R. H. Beamer in the Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kan. Additional paratypes as follows: 4 females, 1 male, Oak Creek Canyon, Ariz., July 31, 1933, R. H. Beamer, 1 male, Aug. 9, 1932, R. H. Beamer; 1 male Huachucua Mts., Ariz., Aug. 2, 1927, R. H. Beamer, 1 female, June 10, 1933, R. H. Beamer, 1 female, Oct. 30, 1937, P. W. Oman; 1 female, Grand Canyon, Ariz., July 28,

female, Prescott, Ariz., Aug. 7, 1932, J. D. Beamer, 1 female, July 29, 1933, R. H. Beamer.

Aligia oculea (Ball)

(Plate XIII, fig. 27)

Eutettix oculea, Ball, E. D., Can. Ent., XXXIII, p. 50, 1901.

Resembling *jucunda*, but smaller with lighter markings, red eyes and vertex more rounded. Length: Male, 4.25 mm.; female, 4.75 mm.

Vertex almost parallel margined, about twice as wide between eyes as length at middle, transverse furrow prominent. Cross veins in tegmen about as in *jucunda*.

Color.—Vertex and scutellum ivory white to light brown with dark markings, basal angles of scutellum darkest; pronotum gray, more or less mottled with fuscous, medan longitudinal vitta and lateral angles often unmarked. Tegmen semihyaline to white with fuscous veins, crossbands usually evident.

Genitalia.—Pygofer oval, somewhat narrower at constriction than distance from there to apex; pygofer hook falcate, almost parallel margined on basal half, then narrowing gradually to a sharp apex. Aedeagus in lateral view slender, almost parallel margined on basal three-fourths, enlarged to twice narrowest width, then narrowing to bluntly angular apex; in ventral view slender, parallel sided and bearing a pair of lateral processes about one-fourth length of aedeagus. Styles about twice as long as basal width, sinuately narrowing to one-fifth basal width on outer fifth, apices long, slender and pointed.

Types.—Lectoholotype male, lectoallotype female in the E. D. Ball collection.

Material studied.—Two females, 1 male, Soldier Summit, Utah, Aug. 13, 1936; 2 males, Grand Canyon, Ariz., Aug. 11, 1927; 1 female, Cove Fort, Utah, Aug. 14, 1929; 5 males, Durango, Colo., Aug. 6, 1937; 3 females, 1 male, Dolores, Colo., Aug. 2, 1900; 4 females, 7 males, Las Vegas, Nev., Nov. 8, 1935; 1 female, St. George, Utah, Aug. 8, 1936; 1 female, Mt. Caramel, Utah, Aug. 9, 1931; 1 male, Richfield, Utah, Sept. 21, 1929.

Aligia curtipennis Hepner

(Plate XIII, fig. 28)

Aligia curtipennis, Hepner, L. W., Jour. of Kan. Ent. Soc., XII, p. 116, 1939.

Resembling *jucunda*, but slightly larger, with a broader vertex, shorter aedeagus and pygofer hook much wider on outer half than next base. Length: Male, 5 mm.; female, 5.75 mm.

Vertex slightly pointed, about three times as wide between eyes as length at middle, transverse furrow prominent. Tegmen marked about as in *jucunda* with cross veins few in number.

Color.—Vertex and scutellum ivory white to yellow with typical markings fuscous and distinct. Pronotum gray, more or less marked with fuscous, a narrow line along posterior margin and median longitudinal vitta unmarked, three pairs of dots along anterior margin usually distinct. Veins in tegmen fuscous with crossbands at least faintly indicated, apical cells partly infuscated.

Genitalia.—Pygofer about as long as width at constriction, apex pointed; pygofer hook extending to margin of pygofer, parallel margined and bent into gosseneck on basal half, broadening to about three times narrowest width on apical third, then narrowing to short, sharp point. Aedeagus in lateral view relatively short, narrowest near base, gradually widening to twice basal width on outer fourth and bearing a pair of lateral processes about one-fifth length of shaft of aedeagus. Styles about twice basal width, sinuately narrowed to outer fifth, apices strongly curved and blunt.

Types.—Holtype male, allotype female and 5 female and 3 male paratypes, Cedar City, Utah, Aug. 13, 1929, R. H. Beamer in the Francis Huntington Snow Entomolobical Museum, University of Kansas, Lawrence, Kan. Other paratypes as follows: 2 females, 3 males, Richfield, Utah, Aug. 19, 1930, E. W. Davis; 4 females, 2 males, Sept. 2, 1930; E. W. Davis; 4 females, 2 males, Sept. 12, 1930, E. W. Davis; 1 female, 5 males, Heber City, Utah, July 25, 1933, Davis and Dorst; 2 females, Salina, Utah, Aug. 15, 1930, E. W. Davis; 1 female, Elsinor, Utah, Oct. 5, 1929, David R. Fox; 1 female, Butlerville, Utah, Aug. 31, 1935, G. F. Knowlton; 2 females, 3 males, Barclay, Utah, July 2, 1931, R. H. Beamer; 2 females, 7 males, Pintura, Utah, Aug. 11, 1929, R. H. Beamer; 4 females, 15 males, Sloss, Colo., Aug. 17, 1929, R. H. Beamer; 2 females, 2 males, Palmer Lake, Colo., July 23, 1900, E. D. Ball, 3 females, 1 male, June 18, 1901, E. D. Ball; 2 females, 3 males, Glenwood Springs, Colo., Aug. 17, 1929, R. H. Beamer; 1 female, 5 males, Taos Pass,

N. Mex., June 13, 1932, R. H. Beamer; 1 male, Oak Creek Canyon, Ariz., Aug. 9, 1932, R. H. Beamer, 1 male, July 31, 1933, R. H. Beamer; 2 males, Clouderoft, N. Mex., June 28, 1932, R. H. Beamer; 1 male, Salida, Colo., July 24, 1900.

Aligia utahna Hepner

(Plate XIII, fig. 29)

Aligia utahna, Hepner, L. W., Jour. of Kan. Ent. Soc., XII, p. 117, 1939.

Resembling *jucunda*, but slightly larger with a sharp vertex, darker markings, less reticulations on tegmen and with the aedeagus somewhat longer. Length: Male, 5 mm.; female, 6 mm.

Vertex distinctly pointed, about two and one-fourth times as wide between eyes as length at middle, transverse furrow quite distinct. Venation of tegmen much as *jucunda*, usually with five to seven veins in the costa.

Color.—Vertex and scutellum ivory white to light yellow with typical markings fuscous; pronotum gray, more or less mottled with fuscous, excepting a broad band along the posterior margin and a longitudinal median vitta, three pairs of dark spots along anterior margin distinct; tegmen semihyaline to white with fuscous veins, crossbands sometimes very faintly indicated, apical cells mostly clear.

Genitalia.—Pygofer oval, about three-fourths as broad at constriction as distance from there to apex; pygofer hook falcate, extending to margin, apex sharp. Aedeagus in lateral view long, clavate, narrowest on basal fourth, apex rounded, more than twice as wide as narrowest place; in ventral view bifurcate on outer fifth and bearing a pair of lateral processes about one-fifth length of shaft of aedeagus. Styles slender, almost three times as long as basal width, sinuately narrowing to outer fifth, apices almost parallel margined, apex curved dorsally.

Types.—Holotype male, allotype female, Granite, Utah, June 26, 1936, M. W. Allen in the National Museum, Washington, D. C. Paratypes as follows: 2 males, Butlerville, Utah, June 16, 1936, G. F. Knowlton; 1 female, 1 male, Panguitch, Utah, Sept. 4, 1932, E. W. Davis; 1 male, Salt Lake City, Utah, July 3, 1931, R. H. Beamer, 1 male, Sept. 5, 1933, Davis and Dorst; 2 males, St. George, Utah, May 1, 1933, E. W. Davis; 1 male, Barclay, Utah, July 2, 1931, R. H. Beamer; 3 males, Cove Fort, Utah, Aug. 14, 1929, R. H. Beamer, 2 males, Richfield, Utah, Fishlake Mt., Aug. 19, 1930; 1 male, Cedar City, Utah, Aug. 13, 1929, R. H. Beamer.

Aligia jucunda (Uhler)

(Plate XIII, fig. 30)

Jassus jucundus, Uhler, U. S. Geog. Surv., III, p. 469, 1877.

Smaller and lighter than *munda* with fewer cross veins and pygofer hook falcate. Length: Male, 4.75 mm.; female, 5.5 mm.

Vertex slightly produced, about two and one-half times as wide between eyes as length at middle, transverse furrow distinct, tegmen with numerous cross veins.

Color.—Vertex and scutellum ivory white to light yellow with typical markings brown, pronotum gray flecked with fuscous, excepting a median longitudinal vitta and a narrow posterior rim. Tegmen semihyaline to white with dark brown veins and usually an indication of a pair of irregular darker crossbands, apical cells infuscated.

Genitalia.—Pygofer oval, rounding at apex, about three-fourths as wide at constriction as distance from there to apex; pygofer hook falcate, broadest beyond base, pointed at apex. Aedeagus in lateral view about five times as long as basal width, greatly enlarged on outer fifth, in ventral view, parallel sided, bifurcate on outer fifth and bearing a pair of lateral processes one-fourth length of shaft of aedeagus. Styles narrow, about three times as long as basal width, sinuately narrowed to outer fifth, apices curved and bluntly pointed.

Types.—Female holotype in the National Museum, Washington, D. C., male allotype, Colorado Springs, Colo., July 19, 1901, here designated at Colorado State College.

Material studied.—Six females, 1 male, Colorado Spring, Colo., July 19, 1901; 1 female, Ridgeway, Colo., July 31, 1900; 1 female, Durango, Colo., Aug. 3, 1900; 1 female, Dolores, Colo., Aug. 2, 1900; 2 females, Heber City, Utah, July 25, 1933; 1 male, Pagosa Springs, Colo., July 5, 1937; 1 female, Nephi, Utah, July 7, 1932; 3 females, Leeds, Utah, Oct. 15, 1932; 1 female, Weber Canyon, Utah, July 4, 1931; 1 female, Bryce Canyon, Utah, Sept. 19, 1935.

PLATE XI

FIG. 1. *Aligia dellana* Ball. Dorsoventral view male genitalia.
FIG. 2. *Aligia manitou* (Ball). Dorsoventral view male genitalia.
FIG. 3. *Aligia chiricana* Ball. Dorsoventral view male genitalia.
FIG. 4. *Aligia occidentalis* Van Duzee. Dorsoventral view male genitalia.
FIG. 5. *Aligia pallida* Hepner. Dorsoventral view male genitalia.
FIG. 6. *Aligia lutea Hepner.* Dorsoventral view male genitalia.
FIG. 7. *Aligia turbinata* Ball. Dorsoventral view male genitalia.
FIG. 8. *Aligia santana* Ball. Dorsoventral view male genitalia.
FIG. 9. *Aligia modesta* (Osborne and Ball). Dorsoventral view male genitalia.
FIG. 10. *Aligia meridiana* Hepner. Dorsoventral view male genitalia.

PLATE XI

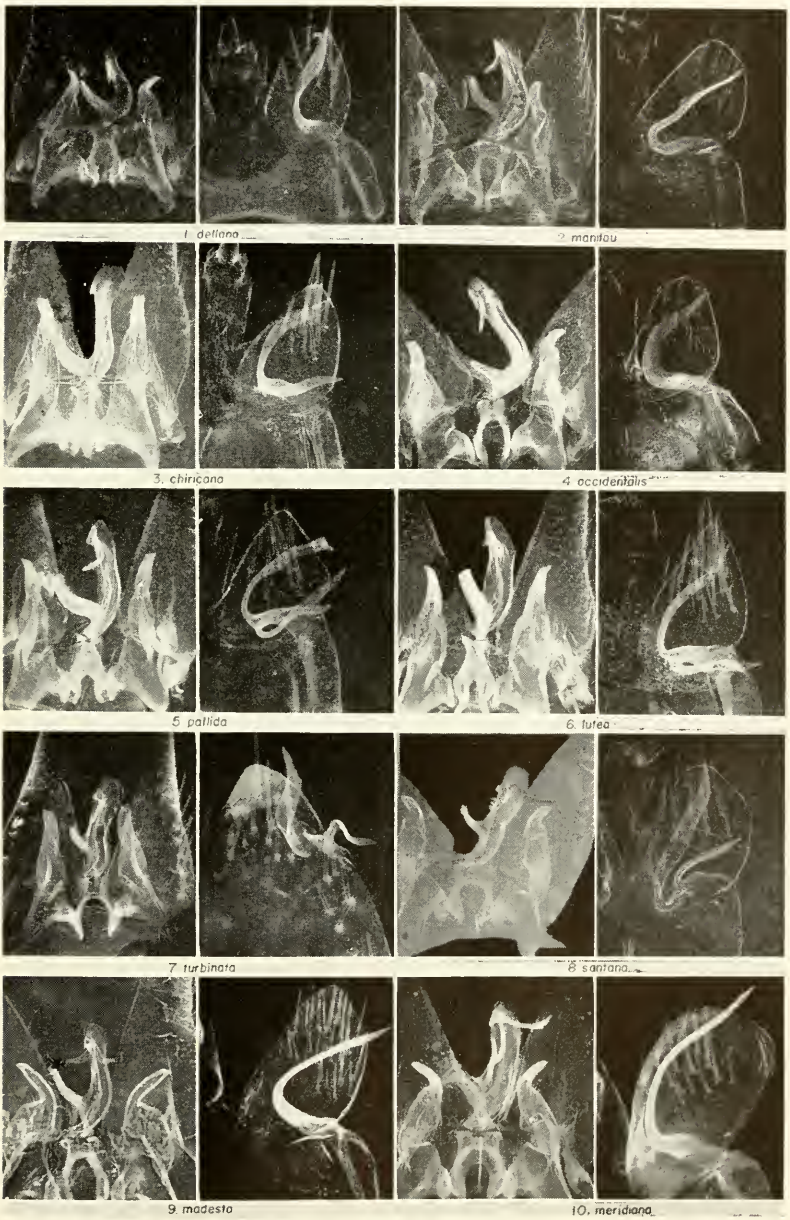

1. delfina
2. mandau
3. chiricana
4. occidentalis
5. pallida
6. tutea
7. turbinata
8. santana
9. madesta
10. meridiana

PLATE XII

FIG. 11. *Aligia bifurcata* Hepner. Dorsoventral view male genitalia.
FIG. 12. *Aligia acutata* Hepner. Dorsoventral view male genitalia.
FIG. 13. *Aligia colci* Van Duzee. Dorsoventral view male genitalia.
FIG. 14. *Aligia californica* Van Duzee. Dorsoventral view male genitalia.
FIG. 15. *Aligia inscripta* (Van Duzee). Dorsoventral view male genitalia.
FIG. 16. *Aligia pallidinota* Hepner. Dorsoventral view male genitalia.
FIG. 17. *Aligia obesa* Hepner. Dorsoventral view male genitalia.
FIG. 18. *Aligia rotunda* Hepner. Dorsoventral view male genitalia.
FIG. 19. *Aligia bifasciata* Hepner. Dorsoventral view male genitalia.
FIG. 20. *Aligia descripta* Ball. Dorsoventral view male genitalia.

PLATE XII

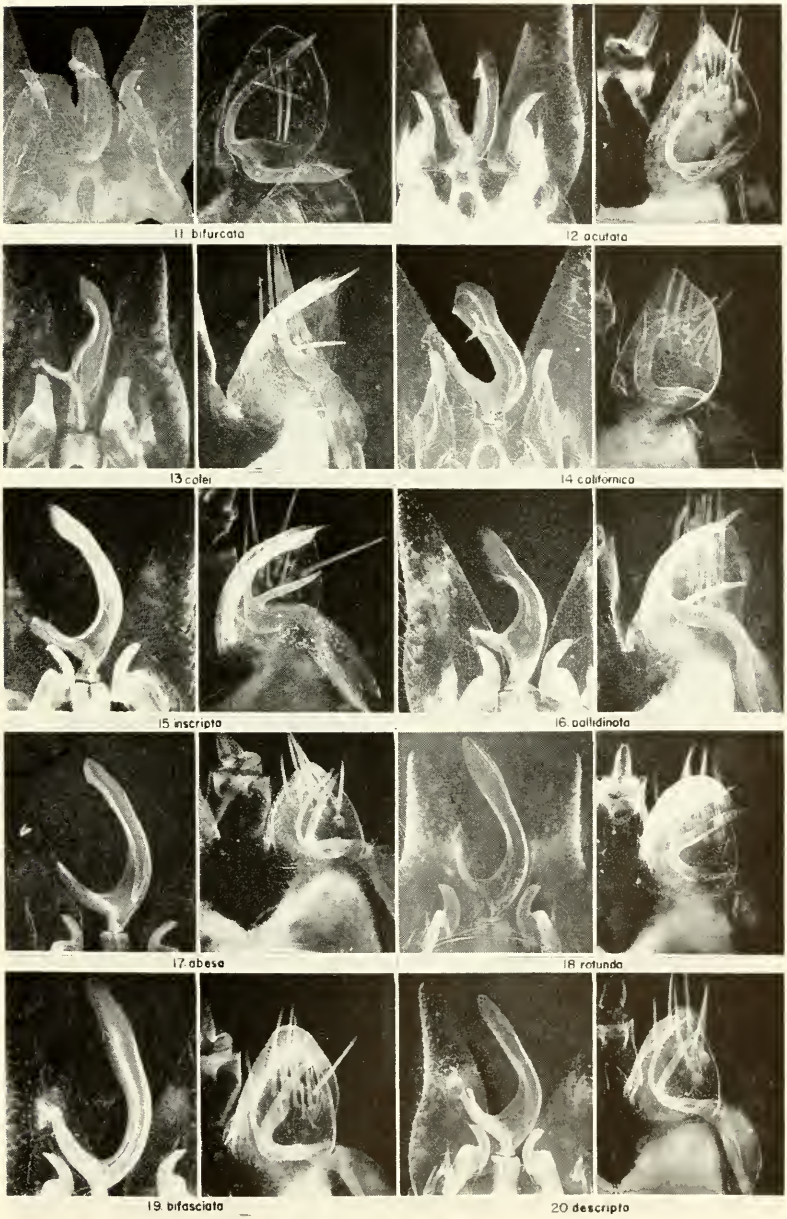
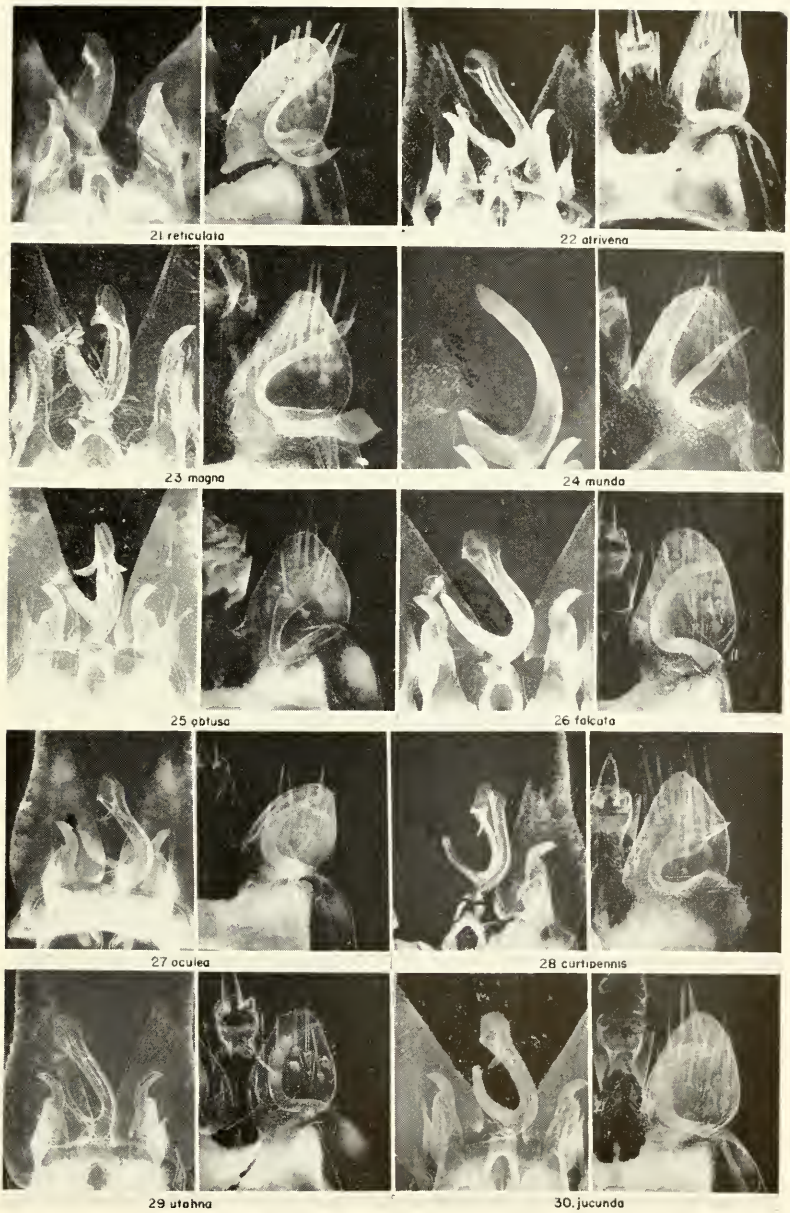

11 bifurcata
12 acutata
13 colei
14 californica
15 inscripta
16 pallidinota
17 obesa
18 rotunda
19 bifasciata
20 descripta

PLATE XIII

FIG. 21. *Aligia reticulata* Hepner. Dorsoventral view male genitalia.
FIG. 22. *Aligia atrivena* Hepner. Dorsoventral view male genitalia.
FIG. 23. *Aligia magna* Hepner. Dorsoventral view male genitalia.
FIG. 24. *Aligia munda* (Ball). Dorsoventral view male genitalia.
FIG. 25. *Aligia obtusa* Hepner. Dorsoventral view male genitalia.
FIG. 26. *Aligia falcata* Hepner. Dorsoventral view male genitalia.
FIG. 27. *Aligia oculea* (Ball). Dorsoventral view male genitalia.
FIG. 28. *Aligia curtipennis* Hepner. Dorsoventral view male genitalia.
FIG. 29. *Aligia utahna* Hepner. Dorsoventral view male genitalia.
FIG. 30. *Aligia jucunda* (Uhler). Dorsoventral view male genitalia.

PLATE XIII


21 reticulata
22 atrivena
23 magna
24 munda
25 obtusa
26 falcata
27 oculea
28 curtipennis
29 utahna
30. jucunda

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X.....Nos. 1-15, weight, 17 ounces.

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XII.....Nos. 1-2, weight, 19 ounces.

XIII.....Pt. I, Nos. 1-9, weight, 12 ounces. Pt. II, Nos. 10-15, weight, 10 ounces.

XIV.....Nos. 1-21, weight, 34 ounces.

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THE UNIVERSITY OF KANSAS
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VOL. XXVIII, pt. II.] NOVEMBER 15, 1942 [No. 9

A Colony of Fossil Neotenic *Ambystoma tigrinum*

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ABSTRACT: A number of urodele skeletal remains, including parts from over 1,250 individuals, have been recovered from a very late Pleistocene sink deposit in Meade county, Kansas. These remains apparently represent a large colony of neotenic individuals which were trapped with the drying of the sink. The average length of the mature individuals was probably about 250 mm. The large number of specimens allows the tracing of the development of particular bones from a very young stage to the condition found in old individuals. There is evidence that at the time these remains were deposited the neotenic habit had developed within the group to such an extent that, at least for the majority of the population, metamorphosis was no longer possible. Such an assumption explains the high concentration of individuals in a small area, and the relatively high percentage of presumed cannibalistic individuals present. There appears to be a retardation of the development of certain morphological characters, as contrasted with neotenic *Ambystoma tigrinum* existing at the present time, but these are not thought sufficient to furnish a basis for taxonomic differentiation of this group as a distinct species.

IN THE course of their work in western Kansas during the summers of 1939 and 1940, field parties of the University of Kansas Museum of Natural History have recovered a large amount of fossil Urodele material. Through the courtesy of Dr. C. W. Hibbard, Curator of Vertebrate Paleontology at this museum, I was given an opportunity to study this material. I wish to express my gratitude to Doctor Hibbard and to Dr. E. H. Taylor for numerous helpful suggestions and criticisms in the course of this study and the preparation of this report.

The majority of the Urodele material was collected from the locality described by Hibbard (1940) as "Meade County Locality No. 13," and by Smith (1940) as the "Jones Ranch beds." The fauna of this locality is known as the Jones fauna. These beds are

a portion of an old, very large sink, which was probably formed in the early part of the late Pleistocene. It appears to have filled nearly to the level of its margins when, near the very close of the Pleistocene, it was tapped by a tributary of Sand creek, the master stream of this particular vicinity. Since this area was far above the level of the creek bed, rapid erosion took place. There is at present an exposed section of 61 feet, the strata of which are given in detail by Hibbard (*op. cit.*).

The stratum in which the fossils occur is a very thin sandy layer of high lime content located near the top of the section. It appears to have been laid down a short time before the sink was tapped, and thus represents a very late Pleistocene stage. The concentration of fossils in this stratum is exceedingly great; an estimated 35,000 vertebrae were taken from about five cubic yards of matrix. Among these vertebrae were over 1,250 cervicals, which afforded the best obtainable check on the number of individuals represented in the collection. In great contrast to this is the small number of some of the thin, fragile skull elements recovered, as, for example, only six prefrontals and no nasals.

All of these remains seem to be referable to the species *Ambystoma tigrinum* (Green); no subspecific allocation is practicable. A race of this species [*A. t. mavortium* Baird] is abundant in the

FIG. 1. Lakeland Sink, one of the typical sinks in Meade county. *Ambystoma tigrinum mavortium* Baird are abundant in such localities.

present-day sinks of this same area. (See Fig. 1.) But, in contrast to these recent specimens, which appear always to metamorphose in the usual manner, the fossil specimens represent a large colony of neotenic forms. All specimens show the larval characters, where these can be determined, with the exception of eleven dentaries and one vomer, and in these the transition to the adult condition is usually incomplete. In size these bones compare quite favorably with those of several neotenic specimens from near Colorado Springs, Colorado. The latter averaged about 250 mm. in length, and it is assumed that the average size of a normal mature individual of the Jones fauna was about the same.

Because of the large number of specimens it is in some cases possible to trace the development of a particular bone from a very young stage to the condition found in old individuals. In this group the dentary lends itself to the setting up of such an age series more readily than any other bone for two reasons. First, the number of characters which indicate increasing age is relatively large in this element as compared with most others; and, secondly, the number of nearly complete specimens of this element is much greater than of any other which would exhibit a correspondingly large number of age characteristics.

The most obvious character indicative of increasing age, particularly in the earlier stages, is an increase in the size and extent of ossification of the bone. There is also a continual increase in the size and number of the teeth; this often results in a crowding together and irregular spacing of the teeth in older specimens. Also correlated with increasing age is a tendency toward the obliteration of the mental groove; this obliteration begins anteriorly and has in no case been found to reach completion posteriorly. In the youngest animals this groove appears to connect with the Meckelian canal over the dorsal surface of the dentary a short distance behind the end of the tooth row. In older specimens, however, a mental foramen is developed just ventral to the posterior portion of the tooth row; it is probably formed by the addition of teeth posteriorly, the ossification of the tooth bases and surrounding tissue roofing over the communication between the two grooves. Probably correlated with a further addition of teeth posteriorly is a migration of the mental foramen anteriorly in relation to the posterior end of the tooth row. Rather early in development a ridge is formed anteriorly on the lingual surface of the bone; the anterior end of the splenial articulates near the posterior end of this ridge. As the anterior end

of the splenial appears to retreat during development, the posterior end of this ridge moves posteriorly to keep pace with it. It seems quite possible that the splenial is in part resorbed and in part fused with the dentary, the fused portion being represented by this ridge. In the following discussion this ridge will, for convenience, be referred to as the "splenial ridge."

These developmental processes occur at approximately equal rates during the earlier stages of growth, but as maturity approaches there appears in most cases a retardation of one or more of the processes in relation to the others. This naturally brings about great individual variation between specimens, so that it is often difficult to determine whether certain characters should be attributed to this individual variation or to true age variation.

There follows a description of several dentaries, arranged as accurately as possible in order of increasing age, illustrating the course of development set forth above.

1. This represents the youngest specimen recovered. The tooth row bears only 19 small, evenly spaced teeth, and has a (chord) length of only 2.1 mm. Most of the teeth, as in all the specimens, have been lost, and are represented only by their bases; the nine teeth that are present in this specimen all have a sharply pointed conical form. The mento-Meckelian region appears entirely unossified, the anterior portion of the bone consisting of little more than the fused bases of the teeth. There is no indication of a splenial ridge. The mental groove is quite deep along its entire length; no mental foramen has developed. (It is to be noted that, although these specimens are the most complete obtainable in their stages of development, even in older specimens the bone is usually broken shortly posterior to the end of the tooth row. If the mental foramen is developed in a manner differing from that described above it is possible that it was originally actually present in these specimens, but still located so far posteriorly as to have been broken off.)

2. In this specimen there are 32 teeth, two of which are still present and show the structure described above. The length of the tooth row is 5.0 mm. Ossification has proceeded so that there is here a definite symphyseal surface, presumably of mento-Meckelian origin, and the anterior teeth now rest on a definite plate of bone. No splenial ridge is present, although the entire anterior portion of the lingual surface is somewhat raised. The mental groove is in about the same condition as formerly, though somewhat weaker anteriorly. The mental foramen has not yet appeared.

3. Even at this early stage a slight discrepancy appears in the rate of development of the various characters, for this specimen shows a slight advance in all features except the number of teeth and, probably as a corollary to that, the continued absence of the mental foramen. There are 31 teeth, in a row 5.8 mm. long; three of the actual teeth are present and continue to show the same structure except for a very slight blunting of their tips. The ossification of the anterior portion of the bone has continued, and there seems to be an exceedingly weak indication of a splenial ridge on the raised lingual surface. Approximately the anterior fourth of the mental groove is so weak as to be almost indistinguishable, but posteriorly it is still quite deep.

4. This specimen has 40 teeth and the tooth row is 7.5 mm. long. The anterior portion is still further ossified and there is a weak, but definite, splenial ridge extending on the raised lingual surface from about the level of the fourth to that of the eighth tooth. The mental groove appears as in the preceding specimen, but there is now a mental foramen present whose anterior end, as seen from the lingual aspect, is at the level of the third tooth from the posterior end of the row.

5. In this case there are 41 teeth on a row 8.6 mm. in length. The anterior portion of the bone is fairly well ossified by this time, and the splenial ridge extends to the level of the ninth or tenth tooth. The mental groove is in the same condition as in the preceding specimen; the anterior end of the mental foramen is at the level of the fifth tooth from the posterior end of the row.

6. The tooth row is 11.1 mm. long and bears 48 teeth. The anterior portion of the bone is well ossified, and the splenial ridge extends to the level of the nineteenth tooth. The anterior third of the mental groove is completely indistinguishable, but the mental foramen retains a somewhat posterior position at the level of the fourth tooth from the posterior end of the row. At approximately this stage the animal concerned had probably reached maturity, so further development can be expected to occur more slowly and be somewhat less marked.

7. In this specimen the tooth row has a length of 12.2 mm. and bears 61 teeth. The splenial ridge extends posteriorly to the level of the twenty-third tooth; as in all succeeding specimens the anterior portion of the bone is well ossified. The anterior third of the mental groove is very weak, but discernible, the middle third is weak, and the posterior third still fairly strong. The mental fora-

men is at the level of the ninth tooth from the posterior end of the row.

8. This specimen affords an excellent example of disproportionate rates of development in the various characters considered. While the tooth row is 12.8 mm. long, it bears only 48 teeth. The splenial ridge extends to the level of the seventeenth tooth. The entire anterior half of the mental groove is very weak, but for the most part discernible; the posterior part is fairly deep, but in certain spots almost overgrown so as to form a canal. The mental foramen, however, remains at the level of the fifth tooth from the posterior end of the row, a fact which is perhaps correlated with the small number of teeth.

9. The length of the tooth row in this case is 13.4 mm., but the number of teeth has increased far out of proportion to this, there being about 75 or 80 teeth present. This great increase in the number of teeth has caused such crowding that near the anterior end a few teeth are displaced laterally to such an extent as to form practically a second row. Some of the bases in both rows are so compressed and distorted that it is doubtful whether they actually bore teeth in life. There is no evidence of a breakage and remending of the jaw, which might conceivably produce such a condition as this. The splenial ridge extends to the level of the eighteenth tooth. The anterior third of the mental groove is lacking. Posterior to this point there is a fairly deep groove extending to the level of the twelfth tooth from the posterior end of the row, at which point the mental foramen is located. A very weak groove extends a short distance posteriorly from the foramen.

10. This specimen has 64 teeth on a row 15.4 mm. in length. The splenial ridge extends posteriorly to the level of the twenty-fourth tooth. The anterior third of the mental groove is lacking, the remainder irregular and, in one spot, discontinuous. The mental foramen is located at the point of discontinuity, at the level of the twelfth tooth from the posterior end of the row.

11. This represents probably the oldest specimen of the group. There are 72 teeth in a row 15.7 mm. in length. The most posterior tooth of the jaw has remained intact; it retains a simple conical structure, but the tip is much more rounded than in the younger specimens described. It is quite probable that the anterior teeth of this and some of the preceding jaws would exhibit weakly the terete structure found in the teeth of Recent examples of this species, and in the more advanced maxillae and premaxillae of this fossil

group. The splenial ridge extends to the level of the twenty-first tooth. The anterior half of the mental groove is almost indistinguishable; the posterior portion is broad and shallow, merging indistinguishably with the general surface of the bone anteriorly and narrowing and deepening toward the mental foramen posteriorly. The mental foramen is located at the level of the nineteenth tooth from the posterior end of the row.

For the purpose of comparison there is here included a description of the condition found in a dentary which appears to be fairly characteristic of recent specimens at about the time of the beginning of metamorphosis. The specimen from which this dentary was taken is one of a large group collected in a sink near the Lakeview schoolhouse in Meade county on August 19, 1940. The tooth row is only 8.6 mm. long, but bears 51 teeth. The extent of ossification of the anterior portion of the bone is at a point between the conditions found in the fifth and sixth specimens of the fossil series, as would probably be the age of the specimen. The splenial ridge extends to the level of the fifteenth tooth. The anterior third of the mental grove is indistinguishable but the remainder is well developed. The mental foramen is at the level of the sixth tooth from the posterior end of the row.

The appearance of a neotenic colony here, in direct contrast to the condition in the same area today, requires some attempt at an explanation. Such an attempt must needs be somewhat superficial because of the fact that the factors controlling neoteny and normal development are so imperfectly known.

This sink, as has been stated, was probably formed in the early part of the late Pleistocene. The sides may at first have been quite steep, so that any salamanders present at the time of sinkage, or which accidentally entered at a slightly later date, were trapped in it. The inability of larvae to leave the sink and lead a normal land existence might account for the appearance of neoteny. But this seems somewhat unlikely, particularly in the case of a very large sink such as this one. Perhaps a more likely explanation is that at some period, which may have been at the time of formation of the sink or at some subsequent time, the surrounding area was very dry and with little shelter. Such conditions might cause the appearance of neoteny. Whatever the factors causing the first appearance of neoteny here, these factors must have continued in existence for a sufficient time that when conditions did change sufficiently to allow a normal land existence this group had become so physiologically

adapted to a neotenic mode of life that it was retained as the normal condition. This trend probably continued further until the point was reached at which even the ability to metamorphose, when faced with conditions necessitating this change, was lost.

Near the close of the Pleistocene, quite late in the development of the sink but still before it had actually been tapped, the previously mentioned tributary of Sand creek probably tapped the ground water beneath the sink, causing a rapid lowering of the water level. This lowering of the water level presumably was so rapid that, if coupled with one or two exceptionally dry years, the sink bottom might become almost completely dry. The particular area in which the fossils occur is thought to be the last part of the sink bottom to become dry; there would thus be a great concentration into this small pond of salamanders previously scattered over a much wider area. Since the majority of them could not metamorphose, food and water shortage caused the death of great numbers within this small area. Their remains were then covered by sediments washing in from the sides of the sink basin upon resumption of normal rainfall.

In consideration of such an explanation, it must be remembered that in most cases known today neotenic *A. tigrinum* larvae will metamorphose when given the chance to do so, even though there is no necessity, so far as can be determined, for them to take such a step. In almost all cases a not too rapidly diminishing water supply will bring about the change. It is for this reason that we must assume the physiological specialization previously mentioned. While it is true that individuals which did succeed in making the change might escape this region, thus leaving no remains here, the great number of specimens found, of which practically none were in the process of metamorphosis, indicates the inability of a large part of the population to do so.

Semi-isolation for a time sufficient to cause, or allow, such a physiological adaptation might reasonably be expected also to produce certain morphological variations from the "normal"; some such variations can be noted. The most obvious of these is the persistence of the notochord throughout the life of the individual. In recent specimens examined the appearance of a vertebral septum severing the notochord appears to be as much a matter of age as of larval or adult condition, for young adults often have a continuous notochord, while in all moderately old neotenes which I have seen the septum has developed. Moreover, in the fossil forms there

seems to be a tendency toward a greater number of palatine teeth in a single row, although this is a variable character and cannot be determined accurately from the material at hand. The individual teeth appear slightly larger than in recent specimens of a comparable age, and exhibit the terete structure in a somewhat weaker state. These are all developmental, as against actual structural, characters, and I believe them to be due to a long period of semi-isolation *in a neotenic mode of life*, and not to be regarded as of particular taxonomic importance.

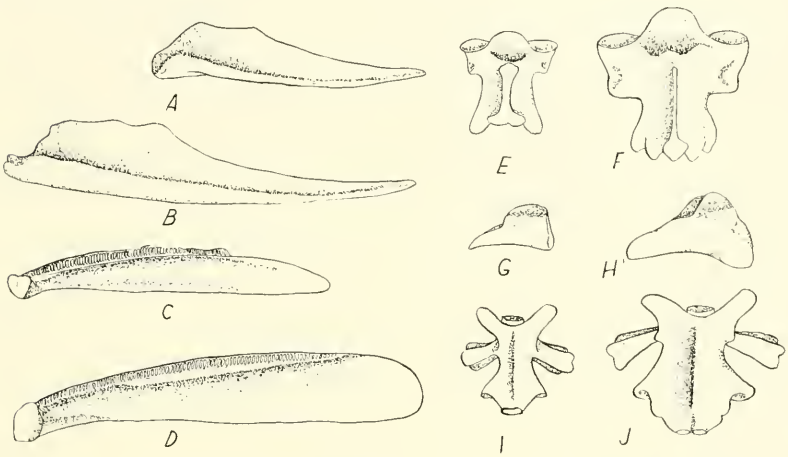

FIG. 2. Comparison of various elements of a 250 mm. neotenic *Ambystoma tigrinum mavortium* Baird, with the same elements from presumed neotenic, cannibalistic individuals of the Jones fauna. A, C, E, G, I represent the angulare, dentary, cervical vertebra, quadrate and trunk vertebra of the Recent neotene. B, D, F, H, J represent, respectively, the same elements in a Jones Fauna neotene (cannibalistic?).

There is great variation within this group, as in recent representatives of the species, but in addition to this "normal" variation there are a number of specimens so far from the average type that we must look for a special cause to bring about the condition which they exhibit. These are exceedingly large specimens, which must have represented individuals up to 400 mm. in length, and which, in addition to the great size, also in most cases exhibit a distortion of form and proportion (fig. 2). If the postulations of Powers (1907) are correct, it seems quite probable that these bones represent cannibalistic individuals. Conditions such as postulated, i. e., a great concentration of numbers with consequent food shortage, would seem to favor the development of such a habit in a relatively large number of indi-

viduals. This is further supported by the fact that remains have been recovered from another deposit about a mile distant which represents a portion of the same sink, but which was laid down at a slightly earlier date, before the drying up process was under way. These remains show the structural characters of the Jones group but, though admittedly the material is much more scanty, in no case do any of these specimens show any indications of this type of abnormal development.

In a dry period such as has been postulated the vegetation of the sink floor, and to a lesser extent of the surrounding area, would be greatly reduced. This lack of vegetation would tend to produce a very rapid wash from the surrounding rims of the basin in following seasons of heavy rainfall. That such a heavy wash probably occurred is indicated by the presence in the deposit of such forms as the ground squirrel and the prairie dog whose normal habitat is on the high prairie. This fact at least fits in with, if it does not directly support, the proposed explanation.

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Extinct Toads and Frogs from the Upper Pliocene Deposits of Meade County, Kansas

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ABSTRACT: This is the third paper dealing with the fossil frogs and toads of Kansas. Taylor (1936), (1939), (1941), dealt with species in the middle Pliocene from which five species were described. In this paper two new genera and eleven new species are described from the Rexroad member of the upper Pliocene.

The following is the list of described forms: *Scaphiopus diversus*, n. sp.; *Neoscaphiopus*, n. gen., genotype, *Neoscaphiopus noblei*, n. sp. (Anura, Pelobatidae). *Anchylorana*, n. gen., genotype, *Anchylorana moorei*, n. sp.; *A. dubita*, n. sp.; *A. robustocondyla*, n. sp.; *Rana parvissima*, n. sp.; *R. fayeae*, n. sp.; *R. meadensis*, n. sp.; *R. ephippium*, n. sp.; *R. rexroadensis*, n. sp.; *R. valida*, n. sp. (Anura, Ranidae).

Mention is made of the presence of two species of *Bufo*, as shown by two types of bufonid ilia. One other species of *Rana* occurs which is presumably new, but the fossil sacrum is too fragmentary to describe.

The presence of ten species of frogs of the Family Ranidae suggests strongly that this region had a climate during the upper Pliocene which provided much more rainfall than at present, thus making western Kansas, during that time, a more favorable habitat for these water-loving species. In contrast, today there are but two ranid species, instead of ten, living in western Kansas.

Since all of the fossil bones of amphibians that have been discovered in the Rexroad quarries were disassociated, it has been necessary to use the sacral vertebrae only, as the basis of the type descriptions.

INTRODUCTION

SOME time ago the fossil frogs and toads belonging to the University of Kansas Museum of Vertebrate Paleontology, from the Rexroad fauna, upper Pliocene of Kansas, were placed in my hands for study. All of the skeletons had been completely disarticulated and disassociated, either prior to fossilization or during the process of recovery from the deposits by washing and sieving. They had been fossilized in either river sand or silt.

The material consists of the following elements: 11 urostyles (coccyges), including those fused with sacral vertebrae; 14 sacral vertebrae; 15 vertebrae other than sacral; 25 scapulae; 23 radioulnae; 47 humeri; 78 ilia; 7 femora; 16 tibiofibulae; 3 coracoids; 1 parasphenoid; 5 dentaries; 2 ethmoids; and 32 other elements referable to tarsals, metatarsals, carpals, metacarpals, and phalanges. From these data one deduces that from these beds, with the present method of collecting, the ilia are most likely to be recovered, since at least 39 individuals are represented; second to these are the humeri representing 24 individuals; the sacral vertebrae represent 14 individuals; while the urostyles, radioulnae, and the scapulae represent 11, 12, and 13 individuals, respectively.

The relative numbers of elements recovered depend largely on their size and solidity. The present method of collecting, that is, washing of the loose matrix and sieving, tends to destroy the more fragile elements, presuming they are present in the quarries originally. The smaller parts may escape through the sieve.

In an earlier study on the anuran fauna of the "Edson beds" of Sherman county, Kansas, I dealt with a somewhat similar lot of fossils, but this material, largely belonging to the genus *Bufo*, was less fragile and the proportions of the elements recovered was different. In all cases the bones were completely disarticulated and disassociated. I was confronted with the problem of a proper method to treat of this fauna, in describing the various species occurring in the collection. It seemed self-evident that the description of each species would have to be drawn from a single element in each case, and this same element used in the case of each species described, in order to avoid the possibility of describing two or more species, based on bones actually belonging to a single species. The element chosen, however, necessarily should be that which had the greatest number of constant differential characters, and one which was very likely to be recovered.

Having available in the Kansas University collection and my own collection, several hundred skeletons of modern Anura, I endeavored to ascertain what bone of the skeleton this might be, comparing, however, only such elements as were likely to be recovered from the fossil beds. This survey led me to the conclusion that the sacral vertebra showed a greater number of obvious, differential, specific characters than other elements, although specific differences were likewise evident in many of the bones.

In consequence, I found it expedient to utilize the sacral vertebra as the basis for the type descriptions, since not only are specific differences evident, but family differences are also apparent, and occasionally generic differences. While this element was not the one occurring most frequently, it was one which, due to its heavier structure, was likely to be recovered.

In the treatment of the Rexroad collection I am following the same procedure as formerly, utilizing the sacral vertebrae as the type specimens.

The reference of all the other elements in the collection to the various species which are indicated by the sacral vertebrae has not been possible at this time. In most cases, however, it has been possible to refer them to family. When the total number of species is

known from the Rexroad fauna, and more complete material is available, one will be able to refer this material to the various species with some degree of certainty. One may always hope to find, at least occasionally, associated bones which will help in this task.

Figures are given of many of the undescribed elements. These show, in their variety, that numerous species are represented.

SYSTEMATIC DESCRIPTIONS

ORDER ANURA

FAMILY PELOBATIDAE Boulenger 1882

GENUS *Scaphiopus* Holbrook 1836

In the Rexroad collection, save for a fragment or two of limb bones which may possibly belong here, this family is represented only by two sacro-coccygeal elements, one apparently belonging to a species of *Scaphiopus* while the other I regard as a member of a new genus. These agree, however, in the fusion of the sacral vertebra with the coccyx, the combined element being procoelous with a single fossa.

Three extinct species of this family are known from the American Pliocene, all being referred, at least tenatively, to the genus *Scaphiopus*. These are *Scaphiopus studeri* Taylor, *Scaphiopus pliobatrachus* Taylor, and *Scaphiopus antiquus* Taylor. Two of these forms are from the "Edson beds," Ogallala formation, middle Pliocene, Sherman county, Kansas; *Scaphiopus studeri* is from a diatomaceous marl, in contact (below) with the "Rhino Hill beds" at the western edge of Logan county, Kansas, also middle Pliocene in age.

Scaphiopus diversus, n. sp.

(Plate XV, figs. 2A, 2B)

Type.—University of Kansas Museum of Vertebrate Paleontology No. 6368. Portion of the combined sacral vertebra and coccyx. Collected by Dr. Claude W. Hibbard and party, 1938.

Occurrence.—Rexroad member (Frye & Hibbard [1941] p. 407), upper Pliocene, locality 3, about 16 miles southwest of Meade, Meade county, Kansas.

Diagnosis.—Characterized by the absence of a bony web between the coccygeal shaft and the diapophyses.

Description of type.—The type specimen consists of the centrum of the ninth (sacral) vertebra, fused with the coccyx; the base of

the sacral diapophysis, is present only on the right side. The distal part of the coccygeal shaft is missing.

The following measurements are given (in millimeters): Total length, 8.4; from anterior end to ninth nerve foramen, 0.9; from anterior end to tenth nerve foramen, 2.0; width of base of the sacral diapophysis, 0.9; diameter of the articular cup, 1.25; width of the centrum of sacral vertebra, 1.15; width at the level of the tenth nerve formamina, 1.45.

There is no trace of lateral shelves along the anterior part of the shaft as is present in *Scaphiopus pliobatrachus* (continuous with the widened portion of the coccyx), or in *antiquus* (arising independently near the base). The shaft is compressed laterally, the elevation being 1.3 millimeters, while the width is 0.56 to 0.6 millimeters. The neural tube on the dorsal part of the shaft terminates by a tiny foramen about 7.0 millimeters back from the anterior end. Posterior to the foramen of the tenth nerve there is a shallow longitudinal groove, the lower edge of which is bordered by a slight elevation. There is practically no trace of a bony web between the coccygeal diapophyses and the side of the shaft (prominent in *S. pliobatrachus*, obsolete in *S. antiquus*). There appears to be no trace of the point of fusion between the two elements on either dorsal or ventral face. Although the sacral diapophyses are absent in the type, it is presumed that these were greatly widened as is typical of the genus.

Whether the type element is from a smaller form than the already described species or whether it is from a young individual I cannot say. The element, based on comparative measurements of the other living species of the genus, belonged to an animal of about 50 mm. snout to vent length, which is smaller than adult *Scaphiopus bombifrons* Cope living in western Kansas at the present time. *S. bombifrons* differs from this form in the presence of the bony web between the diapophyses of the sacrum and the side of the shaft.

Neoscaphiopus, n. gen.

A genus of anuran amphibians of the family Pelobatidae characterized by a fusion of the sacral vertebra with the coccyx and the presacral vertebra. The posterior edge of the presacral vertebra forms a strongly elevated ridge on the dorsal surface of the combined element (see figure Pl. XV, 5A). The bases of diapophyses are much narrowed at their attachment. Genotype *Neoscaphiopus noblei*.

Neoscaphiopus noblei, n. sp.

(Plate XV, figs. 5A, 5B)

Type.—University of Kansas Museum of Vertebrate Paleontology No. 6367. A portion of a combined sacral vertebra and coccyx. Collected by Dr. Claude W. Hibbard and party, 1938.

Occurrence.—Rexroad member, upper Pliocene, locality 3, about 16 miles southwest of Meade, Meade county, Kansas.

Diagnosis.—The sacral vertebra is fused to the presacral vertebra as well as to the coccyx.

Description of type.—The type specimen consists of a part of the sacro-coccygeal element, with both diapophyses and the distal part of the coccygeal shaft missing. The thin anterior edges of the notocoele are broken away.

The measurements, in millimeters, are as follows: Greatest length, 5.1 (estimated length of entire element, 19.0); width of bases of sacral diapophyses, 0.56; distance from edge of socket to base of shaft, 1.5 (missing part estimated at 0.5); from edge of socket to the foramen of the ninth nerve, 2.1; from edge of socket to foramen of the eleventh nerve, 3.8; width of the centrum between ninth nerve foramina, 1.3.

One of the significant characters is the strong contraction of the base of the sacral diapophyses, which has a somewhat greater vertical depth than width. The base of the diapophysis is back a considerable distance from the anterior end of the notocoele, and the tenth nerve foramen is farther posterior than in the numerous species of *Scaphiopus* living or extinct. There is a well-developed bony web between the dorsal surface of the diapophyses and the shaft. At the broken end of the shaft the neural cavity is separate from the main coccygeal cavity, and appears somewhat circular at this point. At the broken end of the coccyx the element is compressed, its elevation being 1.8, the width 1.1 millimeters. Although missing now in the type, it is presumed that the sacral diapophyses were greatly widened.

A ridge 0.45 millimeters high crosses the dorsal surface forming a wavy line. This represents the posterior edge of the presacral (eighth?) vertebra. There is nothing on the ventral surface to suggest the line of fusion. Certain additional characters are evident in the figure. This species is named for the late Dr. G. K. Noble, in recognition of his great contributions to our knowledge of amphibia and reptiles.

FAMILY BUFONIDAE Hogg 1841

GENUS *Bufo* Laurenti 1768

This family, members of which are usually conspicuous in any temperate or tropical living fauna, and whose remains formed a considerable portion of the extinct Anuran fauna recovered from the "Edson beds," Ogallala formation, middle Pliocene, Sherman county, Kansas (Taylor 1936, 1941), is represented in the Rexroad collections by three fossilized bones only. These are, one coccyx and two ilia. The latter are both from the right side, consequently from two different individuals which I believe represent two different species. As work in the Rexroad quarries is being continued it is very probable that sacral vertebrae or other material will be available eventually for adequate description. Consequently I shall not assign specific names at this time. It is of course impossible to state whether the coccygeal element is referable to either of the forms represented by ilia.

Bufo, sp.? Form A.

(Pl. XIX, fig. 12)

This species is represented by No. 6334, the major part of a right ilium, collected by Dr. Claude W. Hibbard and party, 1938, Rexroad member, upper Pliocene, locality 3, about 16 miles southwest of Meade, Meade county, Kansas.

The element, in its present state, lacks the anterior portion; it is 18.2 millimeters in length (estimated total length, 30 millimeters). Its greatest width including the ilial prominence is 6.1 millimeters; the width of the shaft varies between 2.2 and 2.45 millimeters. The shaft is distinctly, but not strongly curved. The dorsal ilial prominence rises about 1.6 millimeters above the level of the shaft. A broad, shallow groove can be traced across the anterolateral face and partly across the top of the prominence. From the posterior inner edge of the prominence, a short, low, curving crest runs back to the termination of the element; from the anterior, inner edge a sharp-edged crest runs diagonally downward nearly across the inner face of the shaft, tending to flatten out and disappear. Above this, and parallel to it, is a slight depression.

On the anterior face is the ilial part of the acetabulum, the edges moderately elevated; below the base of the shaft, just anterior to the acetabulum is a shallow pit, perforated by a small foramen. A thin projection of bone borders the posteroventral part of the acetabulum and is perforated by a foramen near the lower outer edge. The outer

face of the shaft has a curving groove beginning near the upper edge of the shaft base, and terminating at the lower edge, at about the middle of the (entire) bone. The outer surface is rounded while the inner face is less so.

The upper edge of the shaft becomes pinched into an inconspicuous crest, not visible as such from the outer face. The dorsal nerve foramen is nearer to the posterior end of the ilium than to the base of the dorsal ilial prominence.

The fossil is pure ivory in color. Based on comparative measurements and presuming the animal full grown, the ilium belonged to a toad having a snout to vent measurement of about 75 millimeters, a species comparable in size to *Bufo compactilis* Wiegmann.

Bufo, sp.? Form B.

(Plate XIX, fig. 13)

This species is represented by No. 6335, the major part of a right ilium, collected by Dr. Claude W. Hibbard and party, 1938, Rexroad member, upper Pliocene, locality 3, about 16 miles southwest of Meade, Meade county, Kansas.

This element, slightly smaller than the preceding form, is 16 millimeters in length (estimated total length, 26 millimeters). The greatest elevation of the acetabular end is 6 millimeters, while the width of the shaft varies from 2 to 2.5 millimeters.

The shaft is distinctly, but not strongly curved. The dorsal, ilial prominence rises above the level of the shaft about 1.15 millimeters, being somewhat thicker at its base than at the summit. A slight vertical groove is present on the middle of the outer face, and more anteriorly there are two short indistinct grooves. The ridge or crest running back from the inner posterior edge of the prominence is broken away. The anterior crest, which lacks a sharp edge, terminates abruptly near the upper edge of the shaft. The inner face of the shaft is much flattened, but apparently some of the surface has been removed. There is only a trace of a ridge on the inner face, opposite the acetabulum.

On the outer face, is the ilial portion of the acetabulum, the edges of which are somewhat elevated, the cup rather deep, its greatest vertical diameter 2.7 millimeters. Above the acetabulum the foramen is closer to the base of the prominence than to the posterior end of the element. Anterior to the acetabulum, at the lower edge of its base, is a deep pit perforated by a minute foramen; the thin fringe of bone bordering the lower part of the acetabulum is pierced by a foramen near its lower edge.

There is a shallow longitudinal depression on the outer face of the shaft. The upper edge of the shaft is pinched into a crest, not evident when the bone is viewed from the outer, somewhat rounding face.

Compared with the preceding form, the most significant difference is in the different character of the ilial prominence and its position in relation to the acetabulum. In form A, it is largely anterior to the anterior edge of the acetabular cup; in form B it is almost wholly posterior to the anterior edge of the cup. Form B lacks the curved groove on the outer face of the shaft, and the inner face is more flattened and less rounded.

FAMILY RANIDAE Linné 1758

Two genera are considered under this family. These are *Anchylorana,* new genus, and *Rana* Linné, the first with three species, the last with seven species.

GENUS *Anchylorana,* n. genus

A genus of Pliocene frogs characterized by the fusion of the last two (the eighth and ninth [sacral]) vertebrae. The genotype is *Anchylorana moorei,* n. sp.

The significance of the fusion of vertebrae in Anura is not known. Noble (1931) points out that the Roraima toad *Oreophrynella* with only six segments in the column is a terrestrial species. On the other hand *Hymenochirus,* an African form, also with six segments, is thoroughly aquatic. They belong to different families, "hence this reduction in the number of vertebrae is not correlated with a special type of habitat."

In *Atelopus* (Family Atelopidae), a genus related to *Oreophrynella,* Noble found that in some species the last two vertebrae, the eighth and ninth (sacral) vertebrae fused, and in these forms the first and second likewise might be fused in some species. In a few species of *Dendrobates,* also of the same family, he found that in certain species, when the eighth and ninth vertebrae fused, there was a fusion also of anterior vertebrae; in one species the first, second, and third fused; in another the second and third only. Noble also mentions the fusion of the last two vertebrae in a specimen of *Rana caeruleopunctata,* in one of *Rana christyi,* and in one of *Rana pipiens?.*

I have found a single fusion of vertebrae. This was the third and fourth vertebrae of a toad (*Bufo*) in the "Edson beds" fauna, but

this condition was obviously an abnormality, evidenced by a lack of symmetry. In 16 skeletons examined, belonging to *Rana pipiens (sensu lato)*, I find no trace of fusion although it may occur occasionally as an anomaly. The material includes specimens of varied ages and from various localities in Mexico and the United States. No fusions were found in other available ranid species: *Rana cantabrigensis, catesbeiana, palustris,* or *areolata.*

Anchylorana moorei, n. sp.

(Plate XV, figs. 3A, 3B)

Type.—University of Kansas Museum of Vertebrate Paleontology No. 6375. Collected by Dr. Claude W. Hibbard and party, 1939.

Occurrence.—Rexroad member, upper Pliocene, locality 3, Meade county, Kansas.

Diagnosis.—The sacral and the preceding vertebra are fused; a large foramen opens at base of the ventral part of the two condylar projections of the sacral centrum; a ridge is present on ventral surface of the centrum, suggesting the line of fusion, and the possibility that the sacrum is procoelous.

Description of type.—The type specimen consists of the greater part of a sacrum, composed of a sacral vertebra fused to the preceding, eighth(?) vertebra. The distal parts of the sacral diapophyses are missing while those of the attached vertebra are broken away at their bases.

The measurements, in millimeters, for the type specimen are as follows: Total length of combined centra, practically complete, 5.0; the width, practically the same throughout the length, 3.7; width of the narrowest point on the sacral diapophyses, 1.5; width of coccygeal condyles of sacrum, 1.5, 1.35; vertical height of the anterior end of neural canal, 2.1; transverse width, 3.0; vertical height of the posterior end of the neural canal, 1.2; width, 3.0; length of the intervertebral nerve canal, 1.25; width of the neural arch, 4.8.

The coccygeal condyles may be slightly worn since they are a little shorter than what one might expect to be normal. The notch between them is broadly A-shaped, and the surfaces bordering the notch show no wear. The sacral diapophyses are subtriangular in cross section, and are attached to the centrum so that the lines projected from their lower surfaces form a very obtuse angle near the base of the stalks of the condyles. Their broken ends show them to be hollow, the cavity being somewhat triangular in cross section. From the anterodorsal surface, a ridge begins and continues to the

median line where it terminates in an elevated median spine or knob. On the anterior face of the sacral vertebra there are two depressions separated by a medial ridge. There is no ridge on the dorsal surface of the bases of the transverse processes of the eighth vertebra; however, the anterior dorsal edges on both sides become elevated and medially are continuous with a median ridge. This rises to an elevation near the posterior median edge (broken in the type). The prezygapophyses of the eighth vertebra are broken, showing the cavity within the base of the transverse processes.

The centrum seen from below has an angular ridge, the apex directed backwards, suggesting the line of contact between the fused vertebrae. However, if this is actually the case, it may be doubted that this form and the two following are correctly referred to the same genus since the doubly concave eighth vertebra of the Ranidae would not be present (in the other two species the line of contact forms a curve, convex anteriorly, suggesting the eighth vertebra is biconcave). However, until this matter can be settled conclusively I shall leave the three forms associated in the same genus.

The centrum is much flattened dorsoventrally and is hollow. The opening at the posterior end, at the base of the condylar stalks, suggests the presence of a persistant notochord. The notochord persists to a greater or lesser extent in certain species of *Rana*. This is evident in the posterior centra, especially the eighth which is often penetrated by a cylindrical cavity, and the adjoining centra may be pierced by a narrow slitlike opening. Very rarely this is evident in the posterior part of the sacral centrum.

In a skeleton of *Scaphiopus bombifrons* I found the intervertebral parts of the notochord ossified, but instead of becoming fused to the centrum, they remained free, and when the vertebrae were separated, the small notochordal balls fell away from the adjoining notocoeles. The intervening parts of the notochord lacked ossification. I did not find this condition present in other adults, so I presumed this to be a large but subadult specimen.

The species is named for Doctor Raymond C. Moore, Director of the State Geological Survey, State Geologist of Kansas, and Head of the Department of Geology, University of Kansas.

Anchylorana dubita, n. sp.

(Plate XV, figs. 4A, 4B)

Type.—University of Kansas Museum of Vertebrate Paleontology No. 6377. Sacrum, collected by Dr. Claude W. Hibbard and party, 1938.

Occurrence.—Rexroad member, upper Pliocene, locality 3, about 16 miles southwest of Meade, Meade county, Kansas.

Diagnosis.—Sacral and preceding (eighth) vertebrae fused; the anterior vertebra biconcave, penetrated by a circular canal; sacral part with the convex articular surface penetrated for a short distance by a groove, but the centrum is not perforated, and there is no posterior opening present; coccygeal condyles not large. Characters of the diapophyses not known.

Description of type.—The type consists of a sacral vertebra, fused to the preceding (eighth) vertebra, but with the transverse processes of both broken away at the base.

The measurements in millimeters are as follows: Total length of the combined centra, 3.2; width of the centra, 2.5; dimensions of the base of the sacral diapophysis, 1.0 x 0.8; width of coccygeal condyles each, 1.2; vertical height of anterior end of neural canal, 1.8; transverse width of anterior end of same, 2.4; diameter of the intervertebral nerve foramen, 0.85; width of neural arch, 3.8; length of combined arches, 2.2.

The cross section of the sacral diapophysis, where it is broken, is oval rather than triangular, and the cavity within is likewise oval in cross section. The coccygeal condyles are worn and shortened. The notch between them is definitely not A-shaped. The diapophyses are set on the sides of the centrum and arch so that the lines coinciding with their ventral surface, if projected would intersect in the notch between the condyles, forming a very obtuse angle.

There is a very slight ridge arising on the anterodorsal faces of the bases of the diapophyses, which continues as a slight crest bordering the anterior edge of the arch of the sacral vertebra to the middle where there is a median elevation. The posterior face of the arch is directed upward and has a relatively smooth surface. The arch of the preceding vertebra is longer, reaching its greatest elevation medially. There is a slight, median, longitudinal crest, barely indicated (apparently worn). Between the two vertebrae is a deep groove, divided medially by a crest; the suture between the two vertebrae is visible ventrally. The two anterior articular surfaces of the zygopophyses are set nearly at right angles to the surface from which they arise.

The eighth vertebra is amphicoelous and perforated by a wide circular canal; the anterior articular surface of the sacral vertebra seen through this canal, shows a deep groove, but this does not pierce the centrum completely as in *Anchylorana moorei,* nor is there

an opening in the posterior part of the centrum, as obtains in that species.

From a ventral view the point of union between the vertebrae can be discerned more by a color difference than by the presence of a suture. The centrum is apparently more solid than in the preceding species *A. moorei*, and its depth is less than half its width.

I believe there is no question as to the proper association of this form with the family Ranidae. The wear that the element has undergone has probably obscured certain minor characters. I believe this to be from a fully adult animal, as judged by the texture of the bone, of a species smaller than the preceding *Anchylorana moorei*. On the basis of the measurement of the sacrum I estimate the snout to vent length of the animal to have been about 50 millimeters, while I estimate *A. moorei* to have been an animal with a snout to vent length of about 60 millimeters, and judging from the thinner bone, the type may be a young specimen.

Anchylorana robustocondyla, n. sp.

(Plate XV, fig. 1)

Type.—University of Kansas Museum of Vertebrate Paleontology No. 5106. Centrum of sacral vertebra fused to the centrum of the preceding (eighth) vertebra. Collected by Dr. Claude Hibbard and party, 1937.

Occurrence.—Rexroad member, upper Pliocene, locality 3, about 16 miles southwest of Meade, Meade county, Kansas.

Diagnosis.—A rather large frog characterized by very large coccygeal condyles, the sacrum fused with the preceding (eighth) vertebra. The notch between condyles is deep and narrow; the width of a condyle is equal to at least half the width of the centrum. The characters of the diapophyses are unknown.

Description of type.—The combined centrum has only fragments of the bases of the neural arches.

The measurements of the element in millimeters follows: The total length of the combined centra, 6; width of centrum, 4; transverse diameter of the coccygeal condyles, 2.4, 2.3; width of the anterior articular fossa, 3; height of same, 2; depth, 1.5.

The centrum of anterior part (eighth vertebra) is pierced by a small canal which apparently is due to a break. The edges of the opening are broken at the present time. Through a break in the side of the centrum it is possible to observe that although hollow for the most part there is some cancellous bony structure within.

The base of the sacral diapophysis is attached close to the coccygeal end of centrum. There is a well-defined groove on the dorsal surface at the base of the condylar stalks. The dorsal surface of the centra is flat, the ventral surface slightly rounded.

This specimen, though fragmentary, seems to be quite distinct from the two preceding species assigned to this genus. An examination of the figures of the three forms will disclose other differential characters.

GENUS *Rana* Linné 1758

Seven forms of *Rana* are recognizable in the collection. One of these consists of a centrum only and while apparently it is different from the other species, it is not described. I include a figure as evidence of its difference from the described forms.

Rana fayeae, n. sp.

(Plate XIV, figs. 4A, 4B)

Type.—University of Kansas Museum of Vertebrate Paleontology No. 6378. Sacral vertebrae of a small ranid frog, nearly complete. Collected by Dr. Claude W. Hibbard and party, 1938.

Occurrence.—Rexroad member, upper Pliocene, locality 3, about 16 miles southwest of Meade, Meade county, Kansas.

Diagnosis.—Sacrum small, delicate, the lines projected parallel to the inner edge of the sacral diapophyses would intersect at the anterior end of centrum, the angle formed less than a right angle. Sacral diapophyses short, not flattened at terminations.

Description of type.—The sacrum is small and delicate. The tip of the right sacral diapophysis and a section from the side of the terminal portion of the left, is broken away.

The following measurements are given in millimeters: Total length of centrum with condyles, 2.9; greatest width of centrum, 2.3; transverse width of coccygeal condyle, 1.1; width of notch between the coccygeal condyles, 0.5; total width of the vertebra with sacral diapophyses, 8.4; posterior width of neural canal, 2.5; height of the canal, 1.3; depth of centrum, 1.05; median dorsal width of the neural arch, 1.45; length of right diapophysis measured from centrum, 3.95; narrowest width of diapophysis, 1.2; width at distal end, 1.6.

The dorsal surface of the neural arch is crossed by a high, sharp, curving crest which arises from the bases of the diapophyses. Posterior to this, the surface is directed posterodorsally, and a very slight, shallow depression parallels the crest. There is a very indistinct median longitudinal ridge present. Anterior to the transverse ridge the surface is directed anterodorsally, the posterior part some-

what overhung by the ridge; there is a sharp median ridge, but no spine. The anterior zygapophyses have their articular surfaces at right angles to the anterodorsal surface.

The diapophyses are narrowed near their bases, and are somewhat thinner here than at the distal end. They have considerable cancellous bone within.

The species is named in honor of Mrs. Faye Hibbard, who has accompanied her husband, Dr. Claude W. Hibbard, on numerous field trips in this region.

Rana meadensis, n. sp.

(Plate XIV, figs. 5A, 5B)

Type.—University of Kansas Museum of Vertebrate Paleontology No. 6376. A nearly complete sacral vetebra. Collected by Dr. Claude W. Hibbard and party, 1938.

Occurrence.—Rexroad member, upper Pliocene, locality 3, about 16 miles southwest of Meade, Meade county, Kansas.

Diagnosis.—A medium sized frog with the coccygeal condyles rather wide apart and their articular surfaces directed somewhat posteroventrally. A distinct, broad, shallow depression on the ventral surface between the bases of the stalks of the condyles, continues back more than half the length of the centrum. The posterior edges of the sacral diapophyses if extended on neural arch, form a very obtuse median angle.

Description of type.—This sacrum is nearly complete, lacking only the distal parts of the diapophyses.

The following measurements are given in millimeters: Length of centrum and condyles, 2.8; width of the centrum, 2.7; width from outer edges of the coccygeal condyles, 3; lateral width of neural arch, 1.7; base of sacral diapophysis, 1.35; dorsal width of neural arch, 1.0; height of neural canal, 1.7; width of neural canal, 2.5; width including the sacral diapophyses vertebra (broken), 7.1; estimated total width, 8.8.

The curving, transverse ridge arising on the bases of the diapophyses crosses the neural arch, forming a slight knob or spine medially. A slight ridge divides the posterodorsal surface, the lower edge of which is very slightly ridged. Anterior to the transverse ridge, the surface is divided medially by a sharp longitudinal ridge. The articular surfaces of the anterior zygapophyses arise at right angles to the surface.

The dorsal surface of the centrum has an indistinct, broad, shallow, median groove. The ventral surface seen in profile shows a

slight notch at the base of the coccygeal stalks. A broad, shallow median groove arises between the stalks and continues down and forward for two-thirds the length of the centrum. Between the condyles the notch is in the form of a square, the inner edge forming a sharp, thin shelf. There is a very faint groove at the base of the coccygeal stalks on the dorsal surface.

The anterior articular surface of the centrum apparently has a vertical, slitlike depression or groove. A faint tubercle is indicated on the anterior face of the diapophysis near its base.

Rana ephippium, n. sp.

(Plate XIV, figs. 1A, 1B)

Type.—University of Kansas Museum of Vertebrate Paleontology No. 6370. A sacral vertebra with the diapophyses fragmentary, collected by Dr. Claude W. Hibbard and party, 1938.

Occurrence.—Rexroad member, upper Pliocene, locality 3, about 16 miles southwest of Meade, Meade county, Kansas.

Diagnosis.—A small frog with the ventral surface of centrum saddle-shaped; the articular surfaces of the coccygeal condyles directed posteroventrally; a depression between the bases of the condyles only, and a low median ridge on the ventral surface of the centrum.

Description of type.—This sacral vertebra has the left sacral diapophyses broken away at its base, while the distal half of the right is missing.

The following measurements are given in millimeters: Total length of centrum and coccygeal condyles, 3.5; width of the centrum, 3.0; width across the condyles, 3.5; lateral width of the neural arch, 2.0; width of the base of a diapophysis, 1.7; dorsal width of the neural arch, 1.95; height of neural canal, 1.6; width of same, 3.0; width of vertebra with parts of diapophyses, 7.0; estimated total width, 12.0.

The ridge arising on the bases of the sacral diapophyses crosses the neural arch, passing near its anterior edge; while a longitudinal ridge divides the surfaces, anterior to and posterior to the transverse ridge. Posterior to the transverse ridge the surface of the arch is directed upward, while anterior to it, the surface is directed forward. The articular surfaces of the zygapophyses arise from the surface at at an angle a little greater than a right angle. When viewed laterally the centrum is seen to be saddle-shaped; moreover, it is narrower medially than at either end. The anterior articular surface of the centrum has a fine slit-like, vertical groove. The posterior edge of

the neural arch has no trace of a ridge; but a faint trace of a shallow groove is present on the dorsal surface of the centrum.

Rana rexroadensis, n. sp.

(Plate XIV, figs. 3A, 3B)

Type.—University of Kansas Museum of Vertebrate Paleontology No. 6369. Sacral vertebra with the diapophyses partially broken away near the base. Collected by Dr. Claude W. Hibbard and party, 1938.

Occurrence.—Rexroad member, upper Pliocene, locality 3, about 16 miles southwest of Meade, Meade county, Kansas.

Diagnosis.—The coccygeal stalks short, the centrum widest posteriorly at the condyles, not strongly constricted near its anterior end.

Description of type.—The centrum of this rather large frog, has the following measurements, in millimeters: Length of the centrum and condyles, 4.9; width of centrum, 3.3; width at coccygeal condyles, 4.2; lateral width of the neural arch, 2.3; width of base of diapophysis (narrowest), 2.0; height of neural canal, 1.5; width of the neural canal, 3.1; total width of type specimen 10.0; estimated total width, 14.2.

The centrum of the vertebra shows no trace of a posterior notochordal perforation, but the convex anterior condylar surface has a suggestion of a double vertical groove. The ventral surface of the centrum is rather flattened, while the short coccygeal condyles tend to turn posteroventrally forming a slight angle when viewed laterally. The neural arch arises from the upper lateral part. The neural canal is of low elevation having somewhat the shape of a double convex lens. A transverse crest crosses the arch, dividing the surface, the anterior surface edged above by the transverse crest. Between the upper and lower edges there is a slight concavity which is perforated by several minute foramina. The posterior (dorsal) surface of the arch has a slight median longitudinal crest, forming a somewhat quadrangular knob at its termination. The outer surfaces on each side of crest is slightly concave.

The articular surface of the prezygapophysis has a distal, rather flattened area, while the proximal part is somewhat concave. A groove continues back from its upper posterior edge onto the base of the lateral diapophyses. The left diapophysis is somewhat rounding in cross section at its base, becoming a little more triangular at the middle where the terminal part is broken away. This is hollow,

the bone itself being thin. On the right side the diapophysis is broken away at the base, showing a round foramen entering the hollow body of the centrum. On the dorsal surface of the diapophyses, near the base, is a slightly elevated rugosity, and the outer edge of the prezygapophyses has a slight groove on its edge. There is a slight constriction at the outer base of the condyle so that the terminal part is slightly wider than the base. A deep notch extends between the condyles, cutting back somewhat farther on the ventral, than on the dorsal part.

Rana valida, n. sp.

(Plate XIV, figs. 2A, 2B)

Type.—University of Kansas Museum of Vertebrate Paleontology No. 5133. A sacral vertebra, with diapophyses wanting. Collected by Dr. Claude W. Hibbard and party, 1938.

Occurrence.—Rexroad member, upper Pliocene, locality 3, 16 miles southwest of Meade, Meade county, Kansas.

Diagnosis.—Characterized by the elongate stalks of the coccygeal condyles. The centrum is widest through the distal part of the condyles, and much constricted near its anterior end.

Description of type.—The following measurements are in millimeters: Length of centrum with condyles, 5.3; width of centrum, 3.7; width at ends of condyles, 4.6; lateral width of neural arch, 2.6; height of neural canal, 1.9; width of neural canal, 3.3; width of type, 7.0; estimated total width, 17.0.

The convex articular surface of the anterior end of the centrum has a slight trace of a vertical groove, but it is without a notochordal perforation. The ventral surface of the centrum is saddle-shaped rather than flat. The stalks of the condyles are equal to more than one-third of the total length of the centrum, this lengthening of the stalks being due to a strong groove that is continued back on the ventral surface from the deep notch between them. The condylar surfaces differ on the two sides, that of the right side being the larger. When seen from their posterior faces the condyles are definitely egg-shaped with the narrow ends directed outward. The stalk is somewhat constricted just back of the condylar surface. The minimum width of the side of the neural arch is half the total length of the centrum. The neural cavity in cross section is transversely oval, its elevation more than half its width. Seen from above there is a high curving transverse crest, with a small median longitudinal crest rising and crossing the transverse ridge at right angles. On each side

of the median crest the surface is concave, sloping back and down to the posterior face of the arch which forms a narrow edge. Anterior to the transverse crest the longitudinal crest continues down to the anterior edge. On each side the two anterior prezygapophyses arise at an acute angle; the articular surface lacks any concavity and there is no evident groove on the outer anterior edge. A broad, deep groove continues back, anterior to the transverse crest and onto the base of the diapophyses.

The diapophyses are broken away at their bases; in cross section the cavity in the diapophyses seems somewhat rounding, the connecting opening to the cavity of the centrum being obsolete.

Rana parvissima, n. sp.

(Plate XVI, fig. 2)

Type.—University of Kansas Museum of Vertebrate Paleontology No. 6451. Fragment of a sacral centrum, with one coccygeal condyle and the right diapophysis. Collected by Dr. Claude W. Hibbard and party, 1941.

Occurrence.—Rexroad member, upper Pliocene, locality 3, 16 miles southwest of Meade, Meade county, Kansas.

Diagnosis.—A very diminutive anuran, having a rana-like sacral diapophyses, the coccygeal condyle very short, and separated from its fellow by a distance more than four-fifths the transverse width of the condyle. The bone between the condyles forms a sharp, horizontal, posterior edge.

Description of type.—The fragmentary sacrum has the anterior articular surface divided from top to bottom by a well-defined vertical groove. The centrum is not constricted. A marked depression is present between the two condyles, terminating abruptly anteriorly. The coccygeal condyle has practically no stalk, the articular surface being terminated by a deep groove.

The following measurements are given in millimeters: Length of the centrum, 2.0; width of centrum at anterior end, 1.8; estimated width at coccygeal condyles, 2.33; length of diapophysis from centrum (posterior edge), 2.7; estimated total width for entire vertebra and diapophyses, 6.2; width of the base of the diapophysis, 0.5.

The relationship of this small species is very probably with the wood frogs represented in the United States by *Rana sylvatica* and *R. catabrigensis.* No representative of this group is living today in Kansas.

Rana sp. ?

(Plate XVI, fig. 1)

A centrum of a frog differing in the sculpturing of the ventral part of the centrum seems to represent another undescribed species. It is No. 6379, and is figured, Plate XVI, fig. 1. Owing to the fragmentary nature of this specimen, I am not suggesting a name for it. The double ridge on the ventral surface of the centrum is apparently distinctive.

COMMENTS ON THE UNDESCRIBED SPECIMENS

Among the fossil bones of the "unreferred" material I find none that can be referred to either the Families Hylidae or Microhylidae. The members of these families that occur in the Recent faunas of southwestern Kansas are diminutive, and were similar species present in the Rexroad fauna it is unlikely, without special effort, that their very tiny bones would be recognized and recovered.

Save for the two described sacrococcygeal elements I find no bones that can be referred to the Family Pelobatidae. Two ilia are definitely described as belonging to two, presumably undescribed, forms of *Bufo*. The coccyx shown in Plate IV, figs. 10A, 10B (No. 2319) is that of a *Bufo*. It is similar, but not identical with this element in *Bufo compactilis* Wiegmann. With the possible exception of certain radioulnae and scapulae, all the other figured specimens are probably referable to the Ranidae.

Since the greater number of species recovered belong to this family it is not surprising that so large a part of the bones recovered other than the sacra used as type specimens, should likewise be referable to the family. Whether one examines the figured radioulnae, the coccyges, or the ilia it is obvious that several species are represented. In the figures given of the coccyges there are at least six species (possibly more represented) while a still larger number of species are represented among the ilia figured.

At first I was inclined to believe that it would be possible to refer all these figured specimens to the described species. However, I find that, due to my own inadequate knowledge, and the fragmentary character of so many of the elements, this work cannot be done at this time with any degree of certainty. It is to be hoped that the finding of specimens with the bones articulated or at least associated, will make the task possible at some later time.

In the entire lot only three elements were found associated closely enough to be regarded certainly as coming from the same individual.

These are a humerus, a femur, and a tibiofibula represented by Plate XVI, figs. 11, 12, 13 (Nos. 6314, 5107, 5107A, respectively). These bones are from a frog with a probable snout-to-vent measurement of about 100 millimeters, a frog about the size of an adult *Rana areolata* or *R. brachycephala.*

The parasphenoid, Plate XVI, fig. 3A, 3B (No. 6384) an exoccipital, an unfigured specimen (No. 6448), two ethmoids, and 5 dentaries represent the only skull elements recovered. All of these I believe are referable to the Ranidae.

COMPARISON OF THE REXROAD AMPHIBIAN FAUNA WITH THE RECENT FAUNA OF WESTERN KANSAS

The work of Dr. Hobart M. Smith (1934) on the amphibian fauna of Kansas, and that of Tihen and Sprague (1939) on the Fauna of the Meade County State Park provides us with the following list of specimens occurring in Meade county or very likely to be found there since they are present in southwestern Kansas.

SALIENTIA

PELOBATIDAE Boulenger
**Scaphiopus bombifrons* Cope

BUFONIDAE Hogg
**Bufo cognatus* Say
Bufo punctatus Baird and Girard
Bufo insidior Girard
**Bufo woodhousii woodhousii* Girard

RANIDAE Linné
**Rana brachycephala* (Cope)
**Rana catesbeiana* Shaw

HYLIDAE
**Acris gryllus* LeConte
†*Pseudacris clarki* (Baird)
Pseudacris triseriata (Wied.)

MICROHYLIDAE
**Microhyla olivacea* (Hallowell)

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* Reported from Meade County.
† Collected in Meade County by C. W. Hibbard in 1941.

CAUDATA

AMBYSTOMIDAE

**Ambystoma tigrinum mavortium*

The comparative data on Salientia may be tabulated as follows:

	Recent Fauna		Rexroad Fauna	
Family	*genus*	*species*	*genus*	*species*
PELOBATIDAE	1	1	2	2
BUFONIDAE	1	4	1	2
RANIDAE	1	2	2	10
HYLIDAE	2	3	0	0
MICROHYLIDAE	1	1	0	0

Total: Recent, 5 families, 6 genera, 11 species.
Rexroad, 3 families, 5 genera, 14 species.

It seems safe to postulate that a very much larger amphibian fauna was present in the Rexroad than is represented by the finds to date. So large a number of ranid frogs warrants the postulation that the climate was such as to supply a much heavier rainfall, in order to provide sufficient moisture for these water-loving frogs. It seems strongly probable that with forests, which would be a concomitant of the heavier rainfall, numerous species of the HYLIDAE small LEPTODACTYLIDAE and MICROHYLIDAE would be present. It is likewise probable that there was a population of small salamanders, although not a single species has been so far recovered.

For example, the present climate of North Carolina supports an Anuran population of 26 species and subspecies, representing 5 families and 8 genera. The CAUDATA are even richer with 40 species and subspecies, representing 6 families and 16 genera. In the case of the caudate fauna the mountainous character of the country is a contributing factor to its diversity. While the two areas are not entirely comparable, the presence in the Rexroad of so large a number of *Rana* in the fauna suggests the possibility that the climates were similar in character, and at least the anuran fauna may eventually prove even richer than the present day fauna of North Carolina.

Comparison of the sacral vertebrae, which serve as the type specimens of the ranid species of the Rexroad fauna, with those of living specimens in Kansas, shows that none is identical.

The unusual and elaborate perforation of the bone in *Rana catesbeiana* was found in none of the Rexroad specimens. *Rana areolata* has a flattened platform on the ventral surface of the centrum at the

* Reported from Meade County.

base of the coccygeal stalks which is lacking in all the Rexroad specimens.

The present day *Rana brachycephala* apparently approaches closest to *Rana valida*. They are, however, not identical, differing as they do in several details. Thus, the centrum of the former is somewhat constricted but the constriction is around the middle of the centrum instead of near the anterior end as in *R. valida*. The stalks of the coccygeal condyles are short instead of being elongated by a groove between them.

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EXPLANATION OF PLATES

[Numbers refer to specimens in the University of Kansas Museum of Vertebrate Paleontology from the Rexroad member, upper Pliocene, Meade county, Kansas.]

PLATE XIV

FIG. 1A. *Rana ephippium,* n. sp. Type, No. 6370; dorsal view, × 6.
FIG. 1B. Same, ventral view.
FIG. 2A. *Rana valida,* n. sp. Type, No. 5133; dorsal view, × 6.
FIG. 2B. Same, ventral view.
FIG. 3A. *Rana rexroadensis,* n. sp. Type, No. 6369; dorsal view, × 6.
FIG. 3B. Same, ventral view.
FIG. 4A. *Rana fayeae,* n. sp. Type, No. 6378; dorsal view, × 6.
FIG. 4B. Same, ventral view.
FIG. 5A. *Rana meadensis,* n. sp. Type, No. 6376; dorsal view, × 6.
FIG. 5B. Same, ventral view.

PLATE XIV

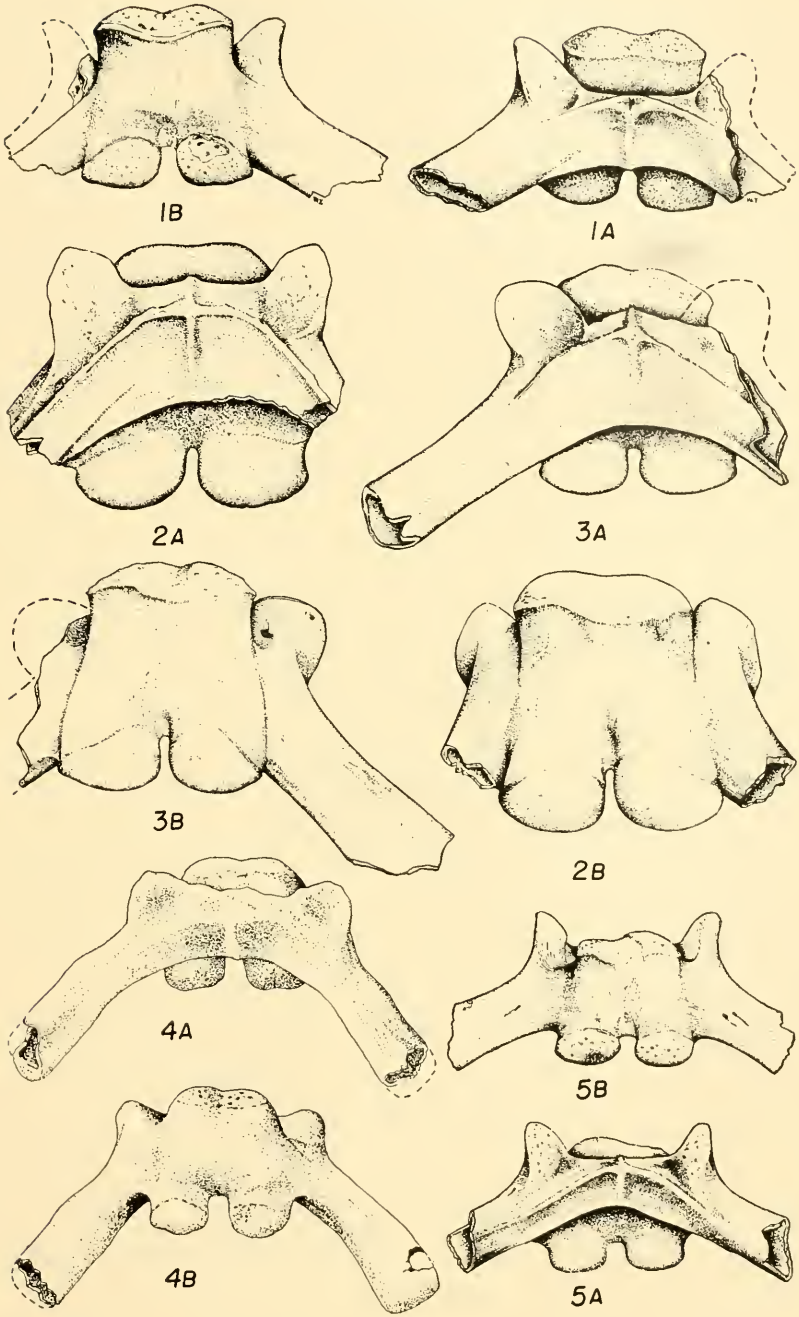


PLATE XV

FIG. 1. *Anchylorana robustocondyla,* n. sp. Type, No. 5106; ventral view, × 6.

FIG. 2A. *Scaphiopus diversus,* n. sp. Type, No. 6368; dorsal view, × 6.

FIG. 2B. Same, ventral view.

FIG. 3A. *Anchylorana moorei,* n. sp. Type, No. 6375; dorsal view, × 6.

FIG. 3B. Same, ventral view.

FIG. 4A. *Anchylorana dubita,* n. sp. Type, No. 6377; dorsal view, × 6.

FIG. 4B. Same, ventral view.

FIG. 5A. *Neoscaphiopus noblei,* n. sp. Type, No. 6367; dorsal view, × 6.

FIG. 5B. Same, ventral view.

PLATE XV

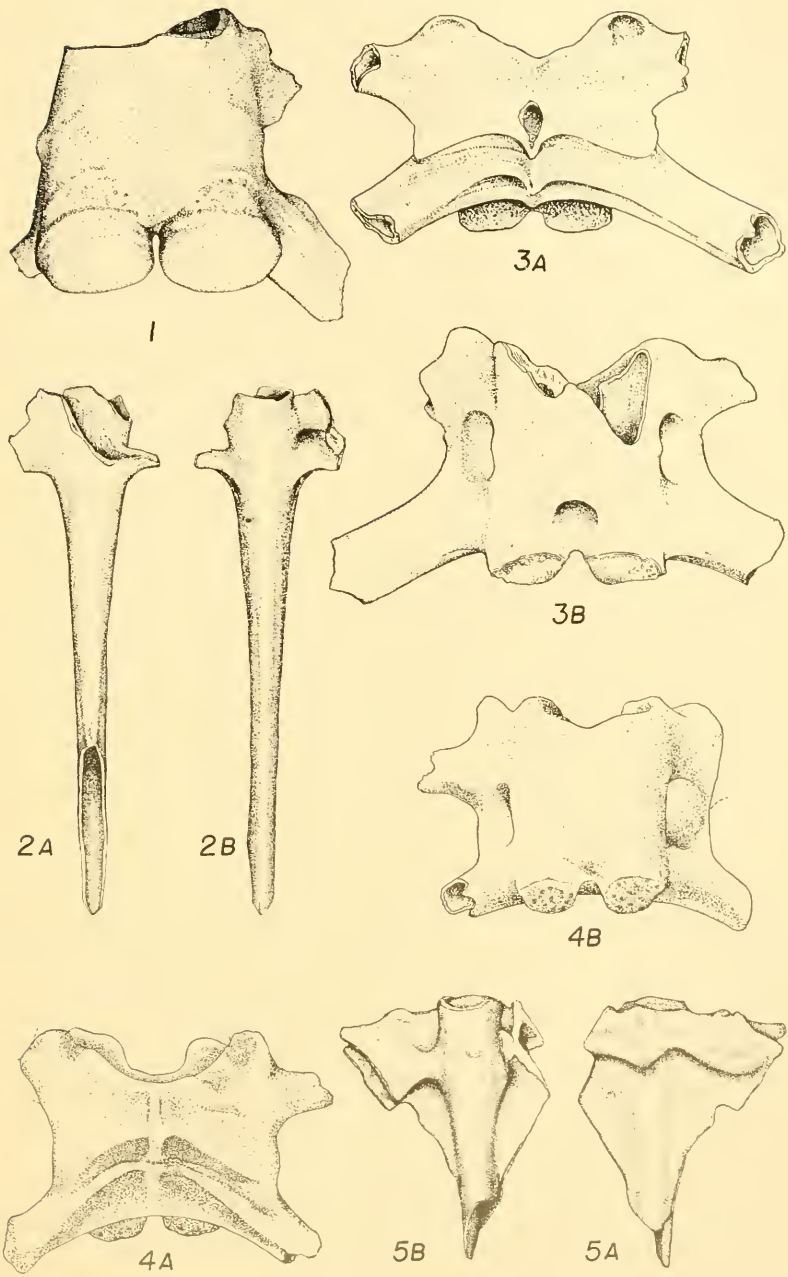


PLATE XVI

FIG. 1. *Rana sp.*, No. 6379, ventral view, × 6.
FIG. 2. *Rana parvissima*, n. sp. Type, No. 6451; ventral view, × 6.
FIGS. 3A, 3B. Anura, No. 6384, dorsal and ventral views of parasphenoid.
FIGS. 4A, 4B. Anura, No. 5096, radioulna, inner and outer view, × 3.
FIGS. 5A, 5B. Anura, No. 6320, radioulna, inner and outer view, × 3.
FIGS. 6A, 6B. Anura, No. 6322, radioulna, outer and inner view, × 3.
FIGS. 7A, 7B. Anura, No. 6321, radioulna, outer and inner view, × 3.
FIGS. 8A, 8B. Anura, No. 6324, radioulna, outer and inner view, × 3.
FIGS. 9A, 9B. Anura, No. 6382, radioulna, outer and inner view, × 3.
FIGS. 10A, 10B. Anura, No. 6381, radioulna, outer and inner views, × 3.
FIG. 11. *Rana sp.*, No. 6314; humerus, × 1½.
FIG. 12. *Rana sp.*, No. 5107; tibiofibula, × 1½.
FIG. 13. *Rana sp.*, No. 5107A; femur, × 1½ (this and the two preceding elements probably from same animal).

PLATE XVI

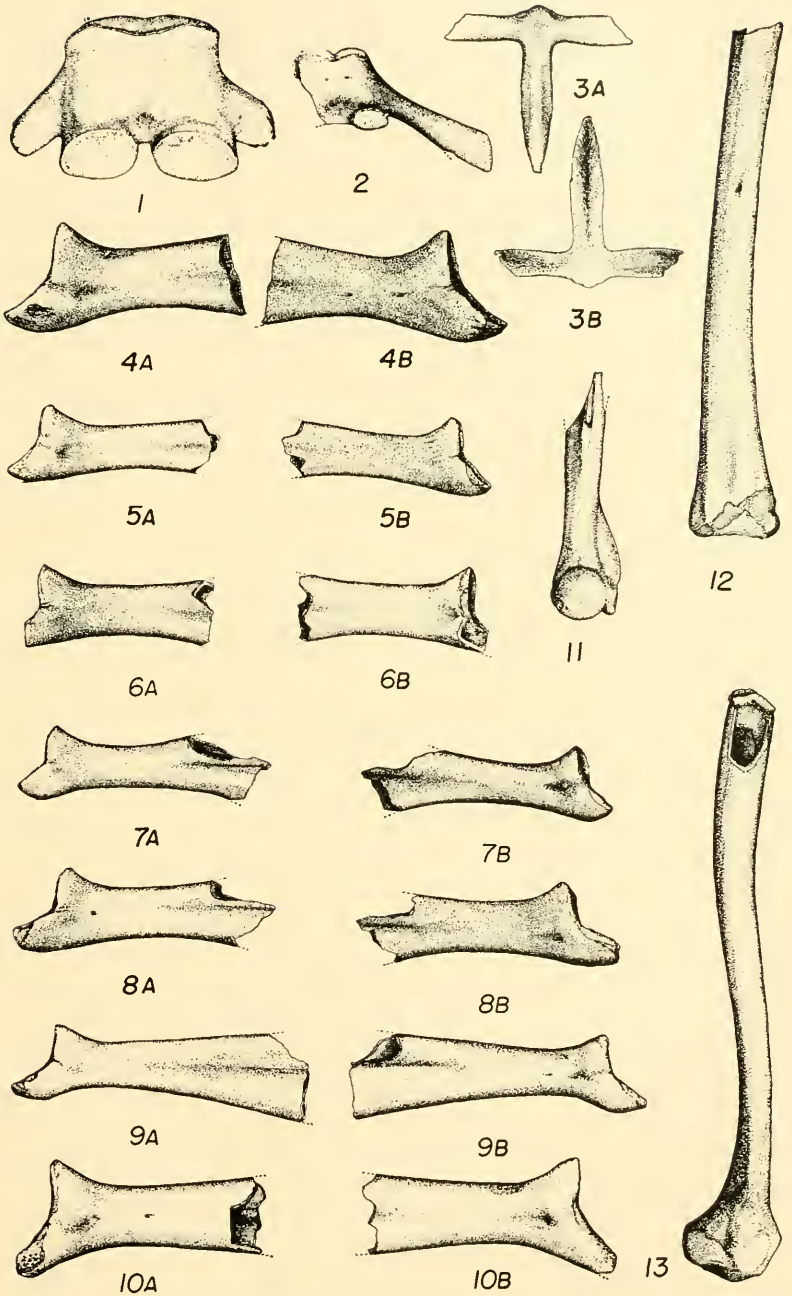


PLATE XVII

FIGS. 1A, 1B. *Rana sp?*, No. 6385; scapula, ventral and dorsal views, × 3.

FIGS. 2A, 2B. *Rana sp?*, No. 5134; scapula, ventral and dorsal views, × 3.

FIGS. 3A, 3B. *Rana sp?*, No. 5105; scapula, ventral and dorsal views, × 3.

FIG. 4. *Rana sp?*, No. 5103; scapula, ventral view, × 3.

FIG. 5A. Anura, No. 6326; fragment of coccyx, lateral view, × 3.

FIG. 5B. Same, cross section, × 3.

FIG. 6A. Ranidae, No. 6327; fragment of coccyx, lateral view, × 3 (probably referable to *Anchylorana*).

FIG. 6B. Same, view of proximal end, × 3.

FIG. 7A. Ranidae, No. 6328; fragment of coccyx, lateral view, × 3 (probably referable to *Rana*).

FIG. 7B. Same, view of proximal end, × 3.

FIG. 8A. Ranidae, No. 6323; fragment of coccyx, lateral view, × 3 (probably referable to *Rana*).

FIG. 8B. Same, view of proximal end, × 3.

FIG. 9A. Ranidae, No. 5088; fragment of coccyx, × 3 (probably referable to *Rana*).

FIG. 9B. Same, view of proximal end, × 3.

FIG. 10A. *Bufo sp?*, No. 6319; coccyx, lateral view, × 3.

FIG. 10B. Same, view of proximal end, × 3.

FIG. 11A. Ranidae, No. 6325; coccyx, lateral view, × 3.

FIG. 11B. Same, view of proximal end. × 3.

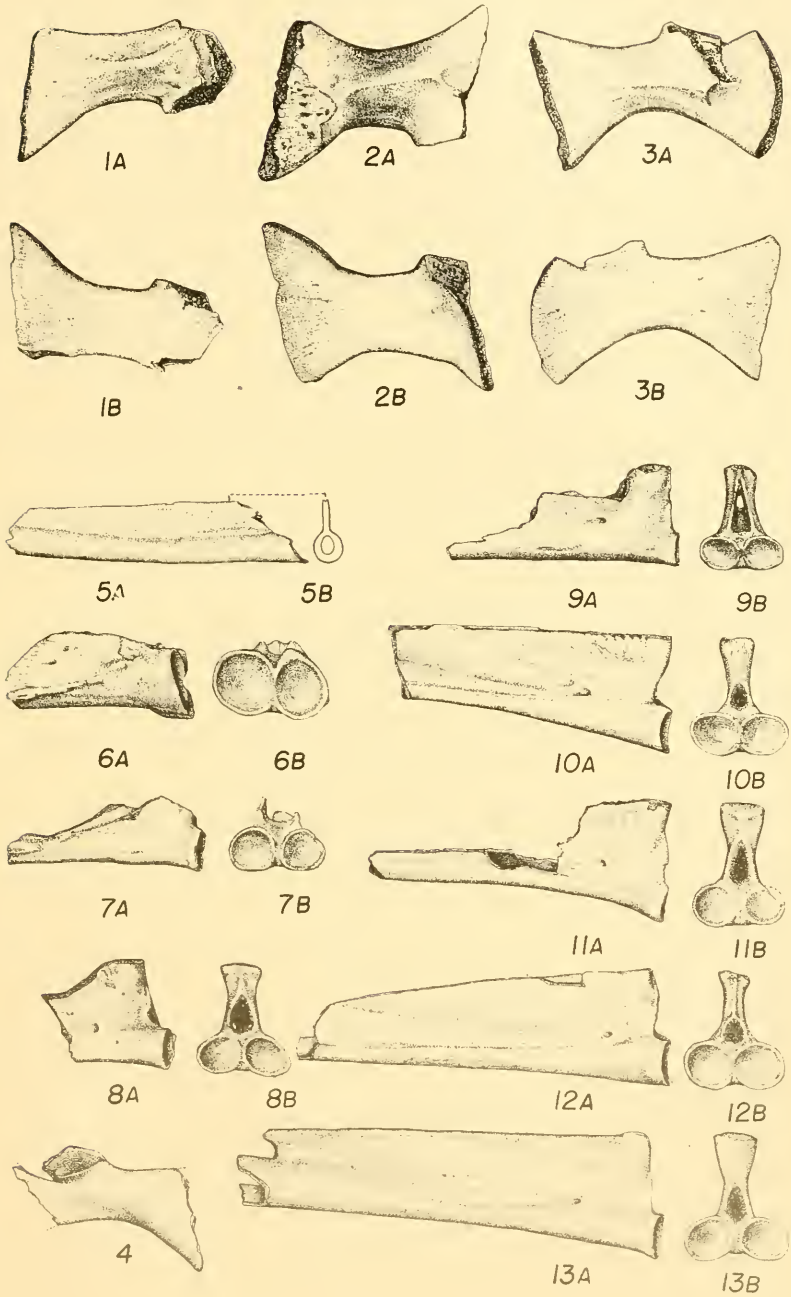
FIG. 12A. Ranidae, No. 6383; coccyx, lateral view, × 3 (probably referable to *Rana*).

FIG. 12B. Same, view of proximal end, × 3.

FIG. 13A. Ranidae, No. 6318; coccyx, lateral view, × 3 (probably referable to *Rana*).

FIG. 13B. Same, view of proximal end, × 3.

PLATE XVII


1A
2A
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2B
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9B
6A
6B
10A
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7A
7B
11A
11B
8A
8B
12A
12B
4
13A
13B

PLATE XVIII

FIGS. 1-23. Anura; ilia, all, × 3. Nos. 1-14 may represent the same species of *Rana*. Nos. 18-23 may represent specimens of another species of *Rana*. Nos. 15-17 represent three different species of unknown generic reference. The figures represent the following museum numbers: 1, 6306; 2, 6356; 3, 6371; 4, 6312; 5, 6352; 6, 6342; 7, 6355; 8, 6373; 9, 6372; 10, 6346; 11, 6311; 12, 6348; 13, 5086; 14, 6331; 15, 6307; 16, 6333; 17, 6315; 18, 6359; 19, 6340; 20, 6341; 21, 6353; 22, 6350; 23, 6358.

PLATE XVIII

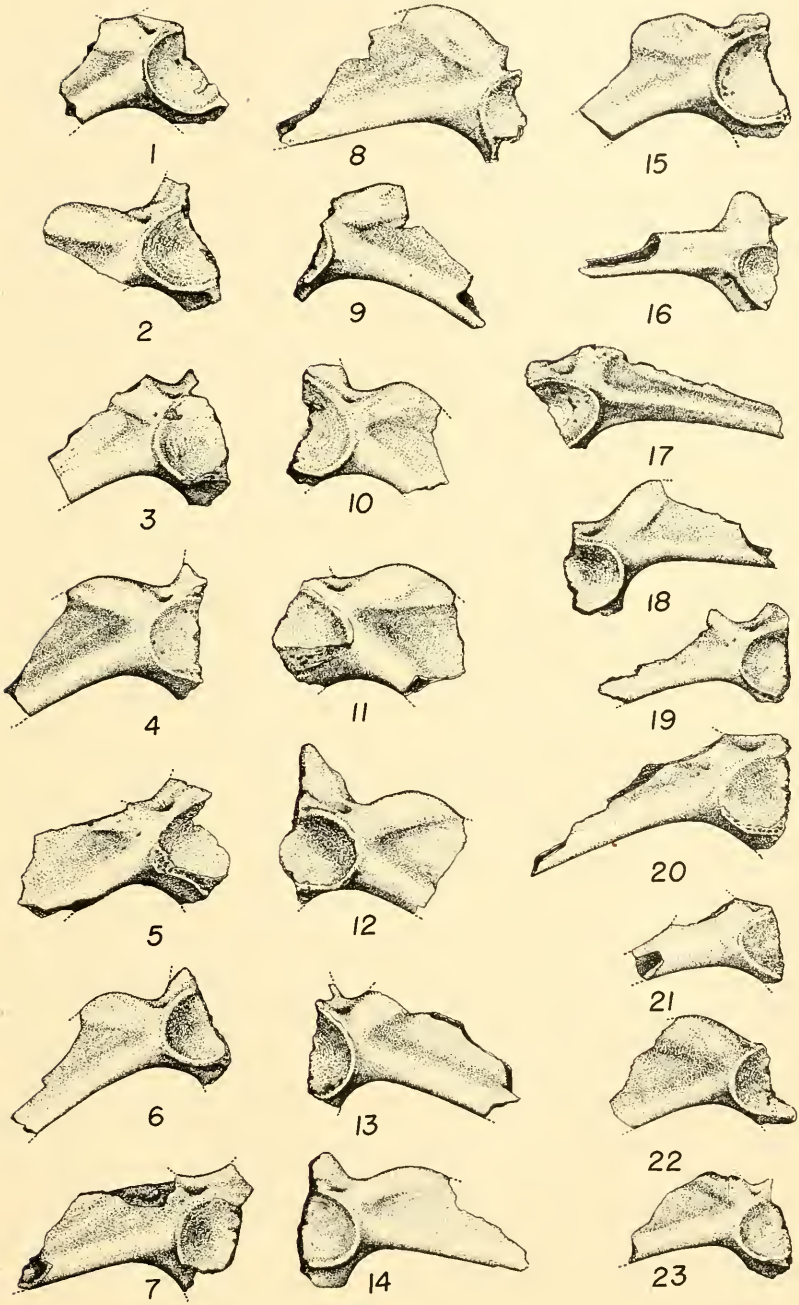


PLATE XIX

FIGS. 1-11. *Rana sp.;* ilia, outer lateral view, × 3 (at least two species are represented). Figs. 1-11 represent the following numbers: 1, 6364; 2, 6365; 3, 6360; 4, 5121; 5, 6317; 6, 6354; 7, 6345; 8, 6362; 9, 6364A; 10, 6349; 11, 6310.

FIG. 12. *Bufo sp.* Form A, No. 6334; ilium, outer lateral view, × 3.

FIG. 13. *Bufo sp.* Form B, No. 6335; ilium, outer lateral view, × 3.

PLATE XIX

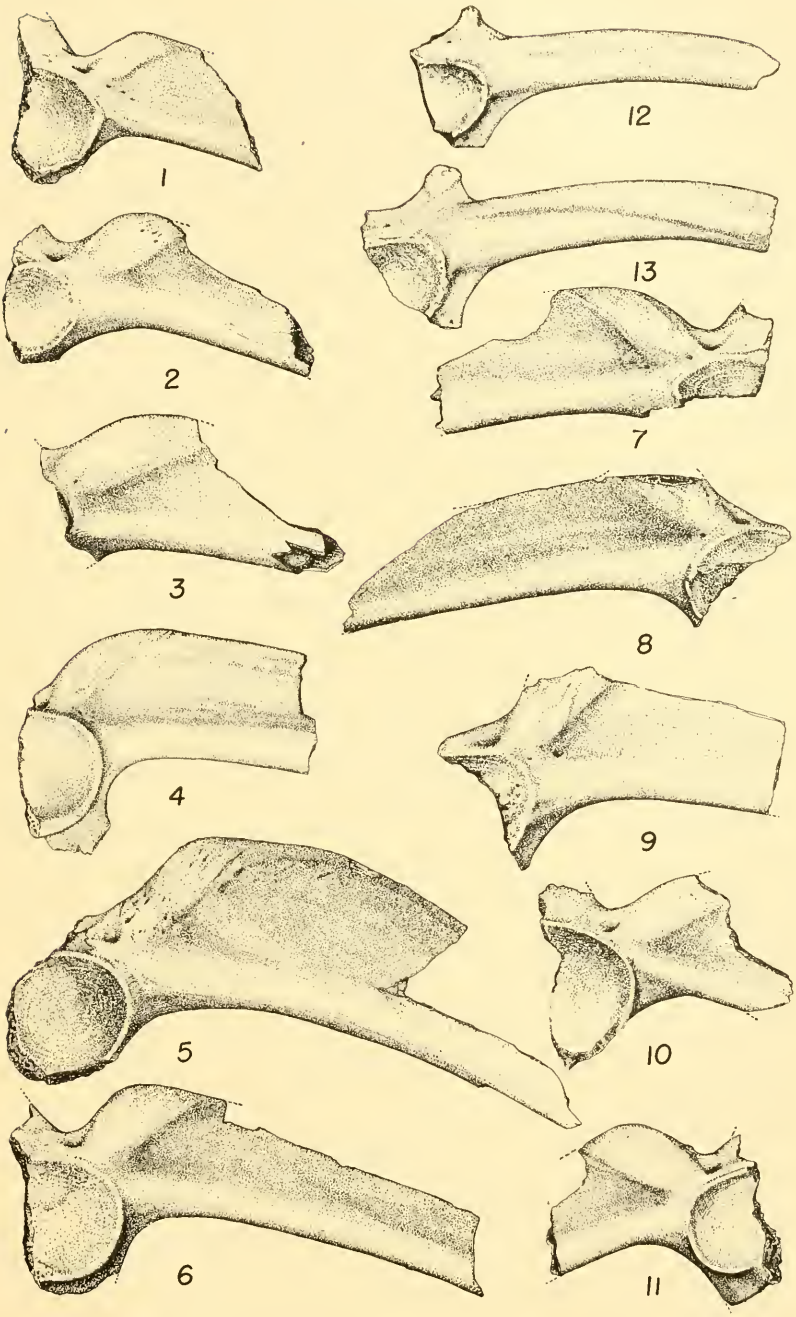
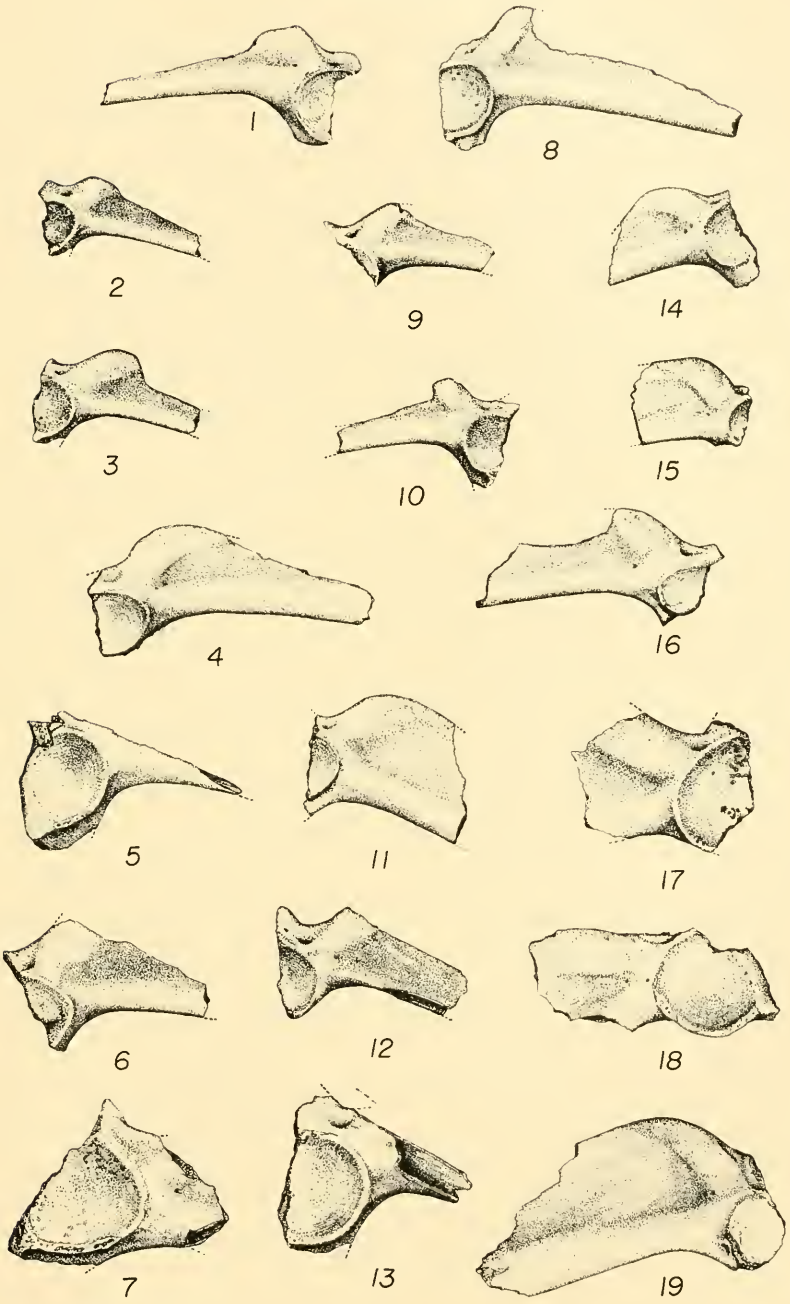


PLATE XX

FIGS. 1-19. Ilia of Anura, mostly referable to *Rana*. All are shown from outer lateral view, × 3. The figures represent the following numbers: 1, 6316; 2, 6336; 3, 6332; 4, 6339; 5, 6363; 6, 6357; 7, 6366; 8, 6337; 9, 6374; 10, 6361; 11, 6309; 12, 6347; 13, 6309; 14, 6336A; 15, 6351; 16, 6338; 17, 6344; 18, 6343; 19, 6329.

PLATE XX



THE UNIVERSITY OF KANSAS
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A New Chimaeroid Fish from the Niobrara Cretaceous of Logan County, Kansas

By CLAUDE W. HIBBARD,
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ABSTRACT: A new ?chimaeroid, *Ichthypriapus hubbsi*, gen. et sp. nov. is described from the Niobrara Cretaceous of Kansas. The type is a complete ?cephalic holder or prehensile spine.

THERE has long been known a bilateral symmetrical element in the University of Kansas Museum of Vertebrate Paleontology collection, which was recovered by Mr. H. T. Martin while cleaning up part of a *Protosphyraena* skeleton that had been collected in the Niobrara Chalk. The specimen under discussion was not associated with the *Protosphyraena* skeleton, only inasmuch as it was in the same block of chalk. Mr. Martin carefully worked it out and placed it away in a drawer in his office labeled "unknown bone." Martin was familiar with the remains of Cretaceous vertebrates, but had never seen even a fragment that resembled this specimen. He searched for years for other specimens or for clues concerning its identity.

In the past years I have shown the specimen to many, hoping that someone had seen something like it. Many have remarked upon its resemblance to an *os priapi*. Dr. E. C. Case and Dr. Carl L. Hubbs, of the University of Michigan, after careful examination, suggest that it is probably the head clasper of a large chimaeroid fish.

During all the many years in which paleontological collections have been made in the Cretaceous of Kansas, chimaeroids have never been found, although they are known from the Cretaceous of New Jersey, Mississippi, and Wyoming. The specimen is too large to be the head clasper of any of the known Cretaceous chimaeroids.[1]

1. For a review of the Cretaceous Chimaeroids of North America see Hussakof (Bull. Amer. Mus. Nat. Hist., 30, art. 19; pp. 195-227, 21 text figs., 2 pls.).

I am indebted to many who have offered helpful suggestions and especially to Dr. E. C. Case and Dr. Carl L. Hubbs for their criticism and advice and for the use of their libraries and specimens. Any error or errors in the interpretation of the specimen are entirely my own. The uniqueness of the specimen seems to warrant placing it on record. The drawings were made by Miss Frances Watson.

Ichthypriapus gen. nov.

Genotype.—*Ichthypriapus hubbsi* sp. nov.; No. 1136F, Kansas University, Museum of Vertebrate Paleontology, complete ?head clasper.

Ichthypriapus hubbsi sp. nov.

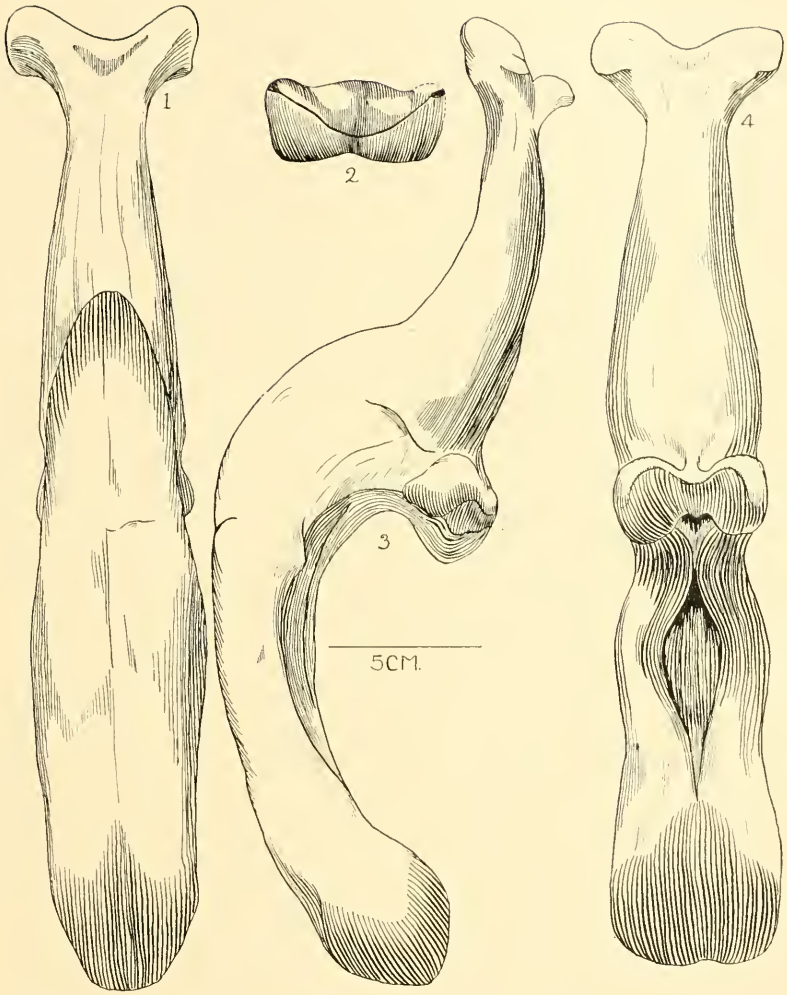
(Figs. 1-4)

Holotype.—No. 1136F, Kansas University, Museum of Vertebrate Paleontology. Complete ?head clasper. Collected by George Sternberg.

Horizon and type locality.—Niobrara, Upper Cretaceous, Logan county, Kansas.

Diagnosis.—A large ?head clasper of a chimaeroid, larger than any head clasper or frontal holder described in previous works. Base not broadened as in *Squaloraia,* but knob shaped. No evidence of denticles or spines on anterior end. Not short arched as in *Ischyodus* and *Chimaera* but more of an elongated S-shape. Approximately nine times larger than the head clasper of *Chimaera,* and possessing a distinct knoblike base.

Description of holotype. The ?head clasper has an over-all length of 150 mm. The base is pitted showing the attachment of well developed muscles. There is evidence of a groove 24 mm. from the base on the ventral side which becomes wider and deeper as it passes anteriorly, reaching a maximum width of 9.5 mm. and a depth of 12 mm.; this is in the region of strongest arch. The groove passes anteriorly in the center of the shaft becoming completely enclosed, and bifurcates near the tip of the structure to open through two small openings with a diameter of 2 mm. on the tip of the horns. (See fig. 2.) Anterior and ventral to this deep groove are two well developed processes for the attachment of muscles. Width across processes, 24 mm. Depth of structure at this point, 42.3 mm. The anterior end tapers down rather rapidly in front of these processes to a narrow transverse width of 13.7 mm. Depth at this point is 9



Explanation of figures: No. 1136F, KUMVP, *Ichthypriapus hubbsi* gen. et sp. nov., holotype, (1) dorsal view, (2) view of anterior end, (3) lateral view, (4) ventral view.

mm. At the point of narrowest transverse width the structure broadens and bifurcates into two hornlike processes, each of which possesses on its lateral surface, near the ventral side, a slight knob-like process. These small processes show no indication of the attachment of muscles. If a cap of spines covered the anterior tip as in *Chimaera* they have been lost.

If a base or handle were developed on the head clasper of *Chimaera* there would be much in common in the two structures since the clasper of *Chimaera* is hollow (filled with uncalcified cartilage) and its base resembles the mid-portion of the fossil specimen. If its spines were removed, however, the clasper of the recent form is an even arch and does not possess an upturned and bifurcated portion on its anterior end as in the fossil.

The specimen shows as much resemblance in its structure to an *os priapi* as to a head clasper of some Cretaceous vertebrate, though to date no form has been recovered from the chalk that would give any clue to its relationship.

This species is named for Dr. Carl L. Hubbs, of the University of Michigan, Museum of Zoölogy.

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Concerning the Snake Genus *Pseudoficimia* Bocourt

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Department of Zoölogy, University of Kansas, and University of Rochester, respectively

ABSTRACT: In this paper *Pseudoficimia frontalis* is discussed, and *Pseudoficimia pulcherrima* sp. nov. is described from Huajintlán, Morelos, México. Both forms are figured.

IN A former paper (Univ. Kan. Sci. Bull., 25, 1938 [1939], pp. 241-2) we placed *Pseudoficimia frontalis* in the genus *Conopsis*. Further studies, however, show that *frontalis* has many peculiarities in morphology; it belongs to a group containing not less than three species (one undescribed), having an extensive range overlapping part of the range of the related genus *Conopsis;* and that there is a very markedly lesser degree of phylogenetic continuity between this group and the genus *Conopsis* than between the several members of the latter genus. We believe the differences between these two groups sufficiently well marked, and indicative of a sufficiently remote phylogenetic connection, that the recognition of the generic distinctness of *frontalis* and related species is necessary.

Available for this genus is the name *Pseudoficimia,* proposed by Bocourt (Études sur les Reptiles et les Batraciens. Miss. Sci. Mex. et Amér. Centr., livr. 9, 1883, p. 572) for *Pseudoficimia pulchra.* It seems that Bocourt was not aware that the species had been described by Cope in 1864 as *Toluca frontalis* (Proc. Acad. Nat. Sci. Phila., Aug., 1864, p. 167), since he does not mention this species in his work.

The genus may be characterized as follows: small to medium-sized colubrine snakes, the tail ⅕ to ⅓ of the total length, the size of the species varying from 440 to 700 millimeters in length, and the total ventral-subcaudal count varying from about 190 to 205. Rostral modified, pointed, and turned up somewhat at tip; internasals

and prefrontals present; nasals partially fused to each other (above nostril) but not fused to labials or internasals; loreal normally absent, leaving the prefrontal in contact with the second labial; one preocular; two postoculars; temporals 1-2-3; two pairs of chinshields, the second reduced.

Maxillary teeth 15 to 17, the posterior not larger than the greater part of the series, most of them showing a posterolateral depression on the posterior edge; pterygoid teeth 9 to 14, the posterior larger than maxillary teeth and with a lateral depression on inner

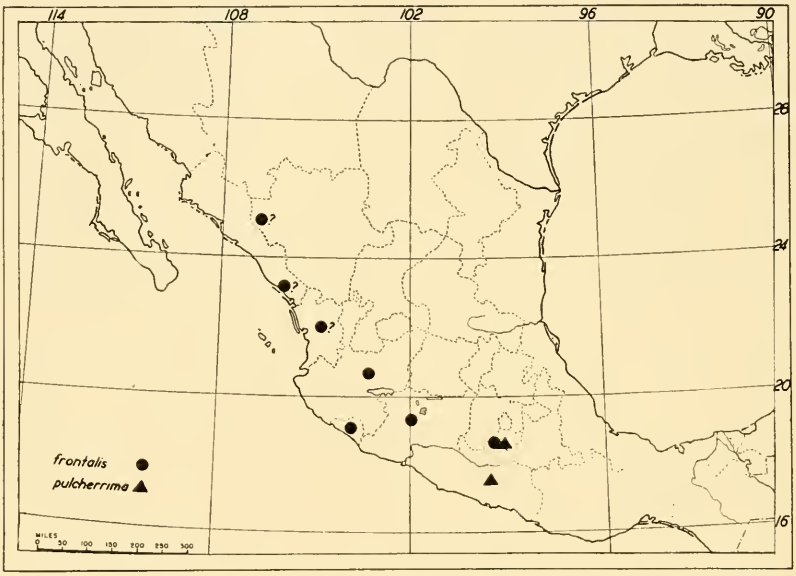


FIG. 1. Distribution of the species of *Pseudoficimia*. Question marks indicate unverified literature records.

posterolateral surface; palatine teeth 9-11, some with depressions, all about the size of the maxillary teeth; dentary teeth 17-20, at least a few with an outer posterolateral depression.

Hemipenes with either few (less than 35) large spines or very small, more numerous spines. Calyces present, coalescing to form short diagonal ridges in some species, when well formed with none or only very minute papules. Sulcus single.

The range of the genus is along the western edge of the Mexican plateau. The known records include localities in southern Sonora, Durango, Sinaloa (Presidio, near sea level), Nayarit, Jalisco, Colima, Michoacán, Morelos and Guerrero.

The following key serves to distinguish the two forms:

A. Hemipenial spines very small, uniform in size, grading into still smaller spines in the area of calyces; latter poorly formed, tending to coalesce; a single dark bar on the frontal region; ventrals, 160-161 ♀, 141-156 ♂; subcaudals, 35-38 ♀, 39-45 ♂; dorsal spots on body 36-49, on tail 10-17; ventrals cream, lateral edges stippled; median yellow spots between dark spots distinct, 1-1½ scales wide; 7(6) lower labials. Colima, Michoacán, Morelos, Jalisco (Nayarit, Durango, Sinaloa?) ..... *P. frontalis* (Cope)

AA. Hemipenial spines relatively very large, 35 or less, not grading into very small spines in the area of the calyces; latter very distinct; a single dark cross bar on frontal region; ventrals 146-155 ♂; subcaudals, 41-43 ♂; 42-48 spots on body; 15-16 spots on tail; yellow spots between dark spots nearly obsolete; ventrals cream, lateral edges stippled; rostral rounded, the part visible from above little more than half its distance from frontal; seven lower labials; a smaller species. Morelos and Guerrero ..... *P. pulcherrima* sp. nov.

Pseudoficimia can be contrasted with its relatives as follows:

Pseudoficimia	*Conopsis* and *Toluca*
1. Area of calyces very distinct, extensive.	1. Area of calyces less extensive, practically obsolete.
2. Calyces or terminal ridges without papillae.	2. Calyces with very distinct papillae.
3. Hemipenial spines homogeneous, either large or small.	3. Spines heterogeneous, large and small.
4. No loreal normally, prefrontal broadly in contact with labials.	4. A loreal or not, but when absent the prefrontal normally not in contact with labials.
5. Nasal partly divided.	5. Nasal entire.
6. Size large, 440-700 mm. total length.	6. Size much smaller, not reaching 400 mm.
7. Total ventral-subcaudal count 190-205.	7. Total ventral-subcaudal count 153-178.
8. Prefrontals and internasals always distinct.	8. Prefrontals fused with internasals or distinct.
9. All teeth averaging slightly more numerous.	9. Teeth averaging slightly less numerous.

Pseudoficimia frontalis (Cope)

(Pl. XXI, fig. 1; text figs. 1, 2)

Toluca frontalis Cope, Proc. Acad. Nat. Sci. Phila., 16, Aug., 1864, p. 167 (type locality Colima).

Pseudoficimia pulchra Bocourt, Miss. Sci. Mex., livr. 9, 1883, pp. 572-573, pl. 35, figs. 12, 12a- 12c (type locality "Mexique"; two specimens from unknown localities).

Ficimia frontalis Garman, Mem. Mus. Comp. Zoöl., 8, 1883, pp. 82, 161 (Colima, description after Cope); Bull. Essex Inst., 16, 1884, p. 30 (places *Toluca frontalis* under genus *Ficimia*).

Geagras frontalis Cope, Journ. Acad. Nat. Sci. Phila., 1876, p. 142; Proc. Amer. Philos. Soc., 22, 1884, p. 177 (Colima and "Guadalaxara"); Bull. U. S. Nat. Mus., 32, 1887, p. 82 (Colima and "Guadalaxara"); Amer. Nat., 18, Feb., 1884, p. 163.

Pseudoficimia frontolis Günther, Biol. Centr. Amer., Rept. Batr., May, 1893, p. 96 (Ventanas [Durango]; Presidio [near Mazatlán, Sinaloa]; Colima; Guadalajara); Cope, Amer. Nat., 30, 1896, p. 1024 (Austro-occidental District); Ann. Rept. U. S. Nat. Mus., 1898 (1900), 945, 1232 (Colima and "Guadalaxara"; the *Geagras frontalis* figured on pl. 16, (hemipenis) from Yucatán, must be another species, perhaps *Ficimia publia*); Taylor, Univ. Kan. Sci. Bull., 24, 1938 (1939), p. 507 (listed from Sinaloa).

Contia frontalis Boulenger, Cat. Snakes Brit. Mus., ed. 2, 2, 1894, p. 270 (Ventanas, Durango; Presidio, nr. Mazatlán [Sinaloa]); Mocquard, Bull. Soc. Philom. Paris, (9), 1, 1899, p. 157 (Sierra del Nayarit [western Nayarit]); Werner, Zoöl. Jahrb., 57, 1929, p. 149 (México).

Conopsis frontalis Amaral, Mem. Inst. Butantan, 4, 1929, p. 182; Taylor and Smith, Univ. Kan. Sci. Bull., 25, 1938 (1939), pp. 241-242, pl. 23, fig. 3 (Hacienda El Sabino, Uruapan, Michoacán); Taylor, Univ. Kan. Sci. Bull., 26, 1939 (1940), pp. 455-456 (Huajintlán, Morelos; *part.*).

The specimens examined and referred to *Pseudoficimia frontalis* are six: the two cotypes, USNM Nos. 31424 ♂ and 31425 ♂, of which we designate the latter as the lectotype since this was the one described by Cope; USNM No. 24941 ♂, young, Guadalajara, Jalisco; EHT-HMS Nos. 5203 ♀ and 5204 ♂, El Sabino, Michoacán; and EHT-HMS No. 5498 ♂, Huajintlán, Morelos. The exact locality at which the types were taken is not known. The collections made by Xantus were obtained in various parts of the state of Colima, as well as in Michoacán.

Whether the specimen listed by Boulenger (1894) from Ventanas, Durango (♂), and the one from Presidio, near Mazatlán (half-grown), belong here or not, we cannot positively say. From the scale counts given, ventrals 150, 153, subcaudals 48, 47, respectively, it seems probable that they do.

The specimen figured by Bocourt (1883) is regarded as the lectotype of *Pseudoficimia pulchra*. The figure given and the description points to the fact that it is a specimen of *P. frontalis*. Apparently no data are taken from the second specimen, which, like the type, is from an unknown locality.

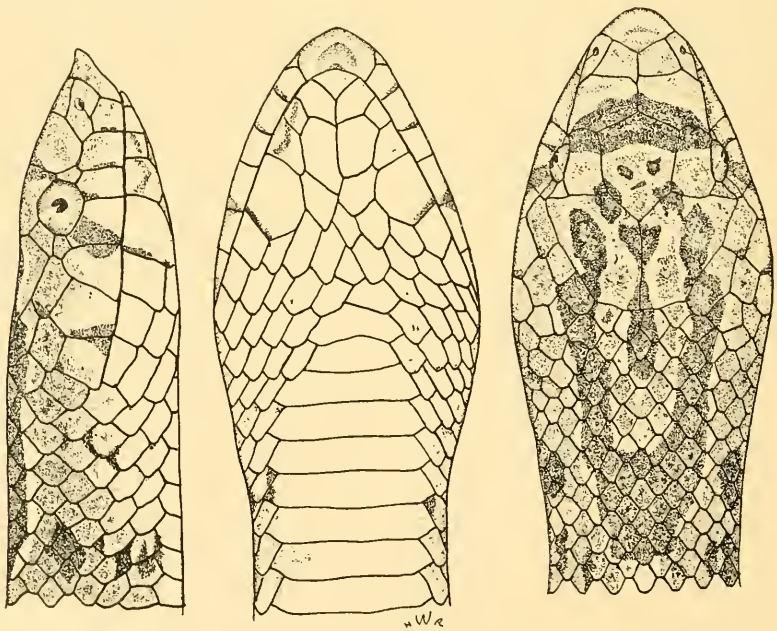


FIG. 2. *Pseudoficimia frontalis* (Cope). EHT-HMS No. 5203, El Sabino, Michoacán.

A specimen from Sierra del Nayarit, reported by Mocquard (1899) is believed to be of this species.

Diagnosis.—Size moderate, known maximum total length 517 mm. in females, 503 mm. in males; hemipenes relatively short, with minute spines, and a distinct distal area of calyces that tend to coalesce and form short longitudinal or diagonal ridges; a single dark band across head just anterior to eyes; ventral scales not pigmented, except laterally; length of portion of rostral visible from above three-fifths to two-thirds the distance between frontal and rostral; seven infralabials, or fewer; ventrals 146 to 156 in males, 160 to 161 in females; subcaudals 39 to 48 in males, 35 to 38 in females.

Variation.—The six specimens examined agree in having 1-1 preoculars, 2-2 postoculars, no loreal, the prefrontal in contact with the second labial, the latter in contact with preocular, third and fourth labials entering orbit, 7-7 supralabials, and 7-7 infralabials (except one, No. 31425, with 6-6). In one (No. 5203) the prefrontal enters the orbit on one side, above the preocular; in all except one (No. 5498) and one side of another (No. 31425) the parietal is in contact with both postoculars, excluding the anterior temporal from contact with the upper postocular (but not from the lower); the posterior chinshields are in contact in four, separated in two; and there are from four to six scales between the chinshields and first enlarged ventral. All have 17-17-17 scale rows. In all the anterior angle of the frontal is very obtuse; the length of the portion of the rostral visible from above varies from a little more than one-half to two-thirds the distance from the frontal to the rostral; frontal a little shorter than parietals in all; nasal divided below nostril, but not above, in all; rostral slightly concave above and slightly turned up.

The hemipenis of No. 5204 is eight caudals long; basal two caudal lengths ridged; adjacent four caudal lengths with very small spines, set singly on large papillae or several on narrow, short, diagonal or longitudinal ridges; in the proximal two caudal lengths of the spinous area, the papillae are separate from each other, but distally they fuse into ridges; a distinct calycular area including the two distal caudal lengths, but the calyces mostly fused to form short, longitudinal or diagonal ridges. In No. 5498 the small spines are visible on the extreme distal ridges. Extremely minute spines almost entirely embedded in tissues are present in all specimens examined.

The characteristic dark crossband on the head in front of the eyes

is present in all specimens, although in one (No. 24961) it is broken medially. A short, longitudinal dark line extends from the anterior parietal region on each side to about the sixth middorsal scale row in the neck, where the two unite at the first of the middorsal series of dark spots. A short longitudinal dark line extends from about the middle of the suture between the parietals to about the second or third scale row on the middle of the neck. These three longitudinal dark lines are variously modified, so that they may enclose a U-shaped light spot, the anterior tips of which may fuse; or there may be three or four separate light spots; generally there is one or two irregular dark spots on the posterior part of the frontal with which the longitudinal lines may fuse.

Further data on these specimens are given in the accompanying table.

Data on *Pseudoficimia frontalis*

Number	Sex	Ventrals	Subcaudals	Total	Spots	Total length (mm.)	Tail length (mm.)	Tail, % of total length
31424	♂	155	40	195	45-15	394	65	16.5
31425	♂	141	44	185	36?	503	96	19.1
24961	♂	146	45	191	49-17	116	20	17.2
5498	♂	156	..	...	41 ..	369	41	....
5204	♂	156	39	195	36-10	450	73	16.2
Durango	♂?	150	48	198	....	245	47	19.2
Sinaloa	♂?	153	47	200	....	...	..	....
"Mexique" ..	♀?	160	38	198	....	454	67	14.8
5203	♀	161	35	196	39-12	517	72	13.9

Pseudoficimia pulcherrima sp. nov.

(Pl. XXI, fig. 2; text figs. 1, 3)

Conopsis frontalis Taylor, Univ. Kan. Sci. Bull., 26, 1939 (1940), pp. 455-456 (*part.*).

Type.—E. H. Taylor-H. M. Smith Collection No. 5497. Collected at Huajintlán, southern Morelos, by E. H. Taylor, 1938. *Paratype.* Univ. Mich. Mus. Zoöl. No. 85711, near Chilpancingo, Guerrero (in mountains).

Diagnosis.—Belonging to the section of the genus having few, large, hemipenial spines. A single dark band crossing head just anterior to eyes; rostral rounded, the part visible above equal to about half its distance from rostral; seven lower labials; ventrals 146-156 (males); subcaudals 41-43 (males); tail length divided by total length, .171 to .177.

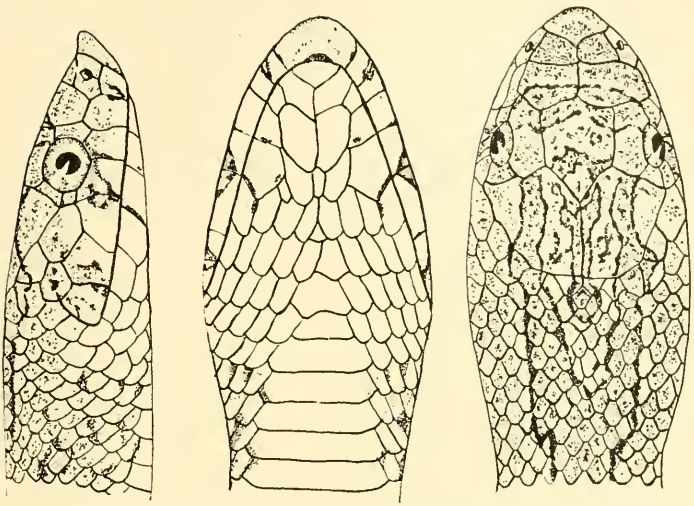


FIG. 3. *Pseudoficimia pulcherrima* sp. nov. EHT-HMS No. 5497, Huajintlán, Morelos. × 3.

Description of the type.—Rostral rounded as seen from above, the length of the part visible from above one-half its distance from the rostral; the posterior part of the scale slightly depressed, and as seen in lateral profile, slightly turned up; internasals less than half the area of the prefrontals, the suture between them half as long as that between the prefrontals; latter broadly in contact with the second labial (on left side the scale is abnormally segmented, leaving a large scale free in the loreal region; normal, however, in paratype); frontal forming a very obtuse anterior angle and a very acute posterior angle, its length a little greater than its distance from tip of snout; parietals considerably longer than wide, longer than the frontal, truncate behind.

Nasal not angulate; a suture from nostril to first labial, partly dividing the scale; loreal normally absent; second labial broadly in contact with the preocular, which is nearly twice as wide as high; two postoculars, both touching first temporal on one side, the upper excluded from it on the left (touching both in paratype); eye moderate, its diameter contained in length of snout about twice, in the distance to nostril 1¼ times; temporals 1-2-3; seven upper, and seven lower labials; first chinshields elongate, narrowed posteriorly; second pair of chinshields well developed, separated by one scale, and from the first widened ventral by two pairs of scales.

Scale formula 24, 17-17-17; ventrals 155; anal divided; subcaudals 41 (originally erroneously stated 44 by Taylor, *loc. cit.*). Total length, 322 mm.; tail, 55 mm.

Hemipenes.—The hemipenes occupy the region covered by 10 caudal scales; 23 spines, the basal ones very large; 3½ basal caudal lengths spineless, the spines confined in the area between this and the 7th caudal (inclusive); distal caudals with calyces, the lower proximal ones edged with minute papules.

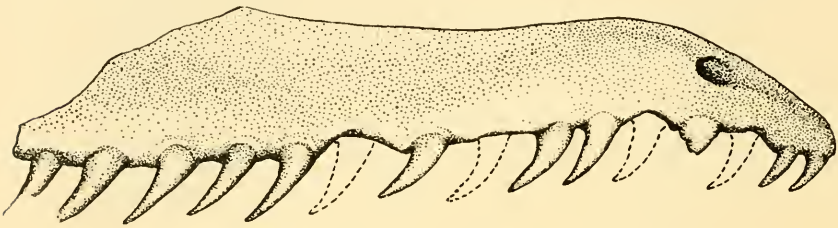


FIG. 4. Right maxilla of *Pseudoficimia pulcherrima* sp. nov. (Type, enlarged).

Teeth.—Maxillary teeth 15 to 17, smaller anteriorly, the posterior teeth not larger than the greater part of the series, all with a more or less distinct lateral groove or depression; nine palatine and 13 pterygoid teeth, nearly all the latter larger than the maxillary teeth, while the palatine teeth are about equal to the maxillaries in size, some showing very faint grooves or depressions near the summit; the anterior tip of the palatine extended somewhat and toothless; 17 dentary teeth, some of the larger ones with feeble grooves, the larger ones nearly the same length as the maxillary teeth.

Color.—Generally smoky lavender above, with a dim, transverse, black edged band crossing the head in front of eyes; a pair of black-edged longitudinal lines begin on anterior part of parietals, continue back, and coalesce six scale lengths back of the parietals; an irregular spot below eye, and the edges of some of the labial sutures darkened; 44 spots on body, 17 on tail; these spots are dim, about three scales long and four wide, and the scales included in them have lighter centers and are edged with black. These are more or less in contact with diagonal lateral spots about one scale wide, which reach to the ventrals; the scales have light centers with black edges. A median series of dim light spots one or two scales wide separate the dorsal spots; only the extreme outer edge of the ventrals with pigment; venter ivory white.

Variation.—The general color of No. 85711 is light grayish lavender, distinctly lighter than the type. There are 49 spots on the body and 16 on the tail. The anterior part of the longitudinal lines on head and neck are connected, forming a short secondary line on parietals. The median dorsal cream spots are almost obsolete. The grooving on the teeth is somewhat more distinct than in the type. The head of this specimen has been injured and certain details of the squamation are indistinct; they agree with those of the type, however, in most details, save in the segmentation of the prefrontal, as occurs on one side in the type; infralabials 6-6; postoculars 1-2; posterior chinshields in contact with each other. Ventrals 146; caudals 43; total length 440 mm.; tail 78 mm.; male.

It is significant that *Pseudoficimia frontalis* occurs at the type locality of *pulcherrima*. A specimen of the former species from Huajintlán has markings and hemipenial characters that agree entirely with those of other specimens of the western species.

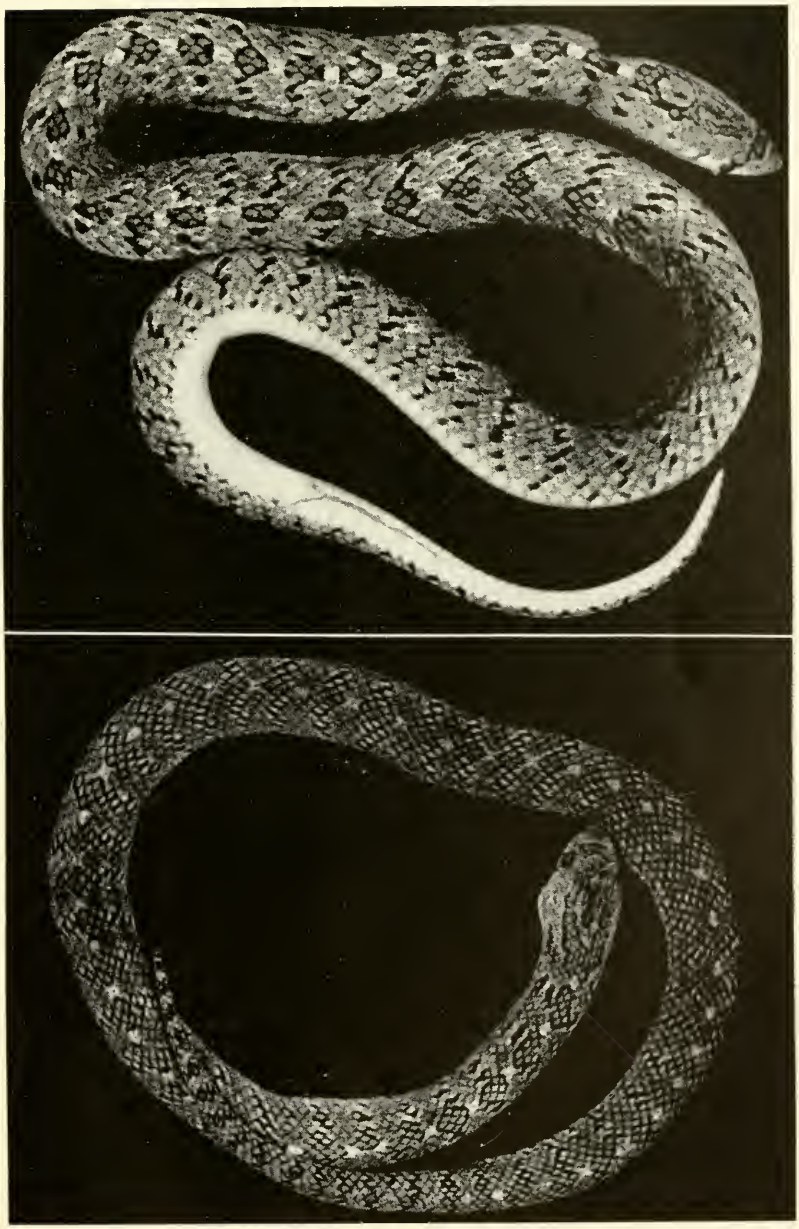
We are indebted to Dr. Helen T. Gaige and Dr. Norman Hartweg for the loan of the paratype of *Pseudoficimia pulcherrima;* also to Mr. C. M. Bogert for the privilege of examining a new species in the American Museum of Natural History which he is describing.

PLATE XXI

FIG. 1. *Pseudoficimia frontalis* (Cope). USNM No. 31424, Colima, cotype. (Upper figure.)

FIG. 2. *Pseudoficimia pulcherrima* sp. nov. EHT-HMS No. 5497, Huajintlán, Morelos. (Lower figure.)

PLATE XXI



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SCIENCE BULLETIN

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A Taxonomic Revision of the Genus *Eutettix* in America North of Mexico (Homoptera, Cicadellidae)*

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ABSTRACT: This paper is a systematic study of the species which have been placed in the genus *Eutettix* since its erection by E. P. Van Duzee in 1892. A key to the species is included, as well as illustrations of male genitalia and last ventral segment of the female. Thirty-three species and subspecies are discussed, of which 21 are new. The following 12 species are retained: *Eutettix quercí* Gillette & Baker, *E. tristis* Ball, *E. pictus* Van Duzee, *E. slossoni* Van Duzee, *E. subaeneus* (Van Duzee), *E. glennanus* Ball, *E. rubianus* (Ball), *E. nitens* Van Duzee, *E. bartschi* Van Duzee, *E. luridus* (Van Duzee), *E. southwicki* Van Duzee and *E. marmoratus* Van Duzee. The following new species and sub-species are named and described: *Eutettix aequalis*, *E. aequalis eberneus*, *E. apicalis*, *E. borealis*, *E. discolor*, *E flavus*, *E. fulvous*, *E. grandis*, *E. hibernus*, *E. latus*, *E. minutus*, *E. nitens pellucidus*, *E. parvus*, *E. pediculus*, *E. planus*, *E. prinoides*, *E. quercí albus*, *E. rugosus*, *E. subspinosis*, *E. variabilis* and *E. acutus*.

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*A contribution of the Entomology Department of the University of Kansas, Lawrence, Kansas.

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INTRODUCTION

THE genus *Eutettix* was proposed by E. P. Van Duzee (Psyche, vi, Aug., 1892, p. 307), naming *Thamnotettix lurida* as the orthotype. A taxonomic revision of the genus was published by E. D. Ball (Proceedings of the Davenport Academy of Sciences, Vol. 12, pp. 27-94, 1907) and the genus was divided into three subgenera—*Eutettix, Aligia* and *Mesamia*. In that paper all the species that have been retained in the genus *Eutettix* were considered as varieties of *subaeneus*, although Doctor Ball recognized *luridus* as the genotype. These varieties were as follows: *pictus* Van Duzee, *tristis* Ball, *slossoni* Van Duzee, *marmoratus* Van Duzee, *southwicki* Van Duzee, *luridus* (Van Duzee), *subaeneus* (Van Duzee) and *querci* Gillette and Baker. Nineteen other species were placed in this subgenus, but these have since been referred to other genera and will be considered later.

Eutettix nitens and *E. bartschi* were described by Van Duzee in 1909 (Bull. of Buffalo Soc. of Nat. Hist., vol. ix, p. 223, 1909). *E. glennanus* was described by Dr. E. D. Ball in 1931 (Fla. Ent., vol. xv, p. 2, 1931) and *E. (Ollarianus) rubianus* was described by Doctor Ball in 1936 (Jour. Wash. Acad. Sci., vol. xxvi, p. 432, 1936).

Apparently all members of this genus feed on various species of oaks, although very little is known about the life histories of the species. Most of the species are found in the southern half of the United States, with Florida and Arizona being especially well represented by species of this genus.

CHARACTERS USED IN CLASSIFICATION

The internal male genital structures proved to be of greatest value in separating the species. The shape and size of the pygofer hook was of primary importance with the pygofer and aedeagus being important in some cases. The last ventral segment of the female was also found useful in separating certain species.

The most important external characters were shape and size of vertex, transparency of tegmen, color pattern and size of species. In this paper the vertex refers to that part of the head anterior to the pronotum and between the eyes; the frons, joining the vertex at its apex, and extending anteriorly to the suture separating it from the smaller, more anterior sclerite (anteclypeus). The vertex, as used here, is sometimes called the crown; the frons is often considered the clypeus; and the anterior sclerite, the clypellus.

The length of specimens refers to the distance from apex of vertex to apex of tegmen. The width of the pygofer is the distance across it at the point of attachment of the pygofer hook; the length of the pygofer is the distance from this point to the apex. The dorsal fork of a bifid pygofer hook is the one arising dorsally and usually extending further posteriorly than the other, or ventral fork.

SYNOPSIS OF GENUS

The genus *Eutettix* resembles *Aligia* but with second cross vein absent and usually with less cross veins throughout tegmina.

Clypeus about twice as long as width at narrowest point, broadest near distal end, both ends convexly rounded; frons gradually broadening from apex to base, sometimes slightly constricted near antennae; margins of lorae circular. Vertex usually about twice as wide as length at middle with the anterior margin typically rounded or slightly pointed, transverse furrow usually present; pronotum about twice as long as vertex at middle and about half as long as wide; scutellum triangular, about as long at middle as pronotum. Tegmina with few extra cross veins and with the second cross vein absent.

Typical color pattern if present as follows: Loral suture darkened, with a dark spot on each lateral margin; frons with about seven pairs of oblique markings; vertex with four pairs of dots, one just inside each ocellus, a pair near apex and two just inside each eye along posterior margin; transverse furrow darkened. Anterior half of pronotum usually lighter, with four pairs of dark spots along anterior margin sometimes present; scutellum with a large spot just inside each basal angle, a pair of smaller spots between these, and

transverse furrow, darker. Tegmen with clavus and adjacent area of corium usually more opaque than remainder of corium.

Genitalia: Pygofer triangular or oval; pygofer hook prominent, single or bifurcate. Plates slender, pointed; aedeagus with apical or lateral processes.

SYNONYMY

The following species, originally considered in *Eutettix*, have since been placed in the genus *Norvellina:*

clarivida (Van Duzee)
seminuda (Say)
scitula (Ball)
pallata (Ball)
pervelegantis (Ball)
mildredae (Ball)
columbiana (Ball)
snowi (Ball)
saucia (Ball)
nevadae (Ball)
pulchella (Baker)
pannosa (Ball
rubida (Ball)
texana (Ball)
bicolorata (Ball)
chenopodii (Osborn)
scabra (Osborn & Ball)

The species listed below described as Eutettix or later placed therein are now as follows:

Bandara johnsoni (VanDuzee)
Bandara animana (Ball)
Bandara aurata (Ball)
Aligia oculea (Ball)
Aligia munda (Ball)
Aligia modesta (Osborn & Ball)
Aligia manitou (Ball)
Menosoma acuminata (Baker)
Menosoma cincta (Osborn & Ball)
Platymetopius palliolatus (Ball)
Ollarianus strictus (Ball)
Phlepsius albidus (Ball)
Phlepsius strobi (Fitch)
Phlepsius zizcac (Crumb)
Colladonus amandus (Ball)
Colladonus incertus (Gillette & Baker)
Exitianus exitiosus (Uhler)
Athysanella terebrans (Gillette & Baker)
Macrosteles vanduzei (Gillette & Baker)

The following three species were found to be synonyms: *Eutettix osborni* Ball of *Opsius stactogalus* Fieber; *E. magnus* Osborn of *E. pictus* Van Duzee; and *E. brunneus* Osborn of *E. marmoratus* Van Duzee.

The following species do not belong to the genus *Eutettix,* but until their generic affinities are better understood, they are retained in this genus for convenience.

tenellus (Baker)
goniana Ball
insanus Ball
pauperculus (Ball)
coronatus Ball

KEY TO THE SPECIES OF EUTETTIX

1. Tegmen semihyaline white to fulvous, without a light spot near apex of clavus; color about the same throughout 2
   Tegmen dark, or if light, with at least a semblance of a light spot near apex of clavus (except *rubianus*, which is characterized by 2 to 4 distinct black markings along margin of vertex); color pattern usually evident 13
2. (1) Vertex flat, pointed, decidedly longer at middle than next eye; aedeagus with a pair of long, bifid, apical processes; pygofer hook relatively small 3
   Vertex not so flat, apex rounded, only slightly longer at middle than next eye; aedeagus without a pair of long bifid apical processes; pygofer hook larger 4

3. (2) Vertex decidedly less than twice as long at middle than next eye; male more than $5\frac{1}{2}$ mm. in length, female more than 6 mm. in length; pygofer hook extending almost to apex of pygofer.....(1) *acutus* n. sp.
Vertex almost twice as long at middle as next eye; male less than 6 mm. in length; pygofer hook extending only to middle of pygofer and with a fleshy lobe near base.....(2) *planus* n. sp.

4. (2) Pronotum with longitudinal stripes evident; both forks of pygofer hook much longer than pygofer, ventral fork longest.....(3) *grandis* n. sp.
Pronotum without longitudinal stripes; forks of pygofer hook scarcely longer than pygofer, ventral fork never distinctly longer than dorsal..... 5

5. (4) Males $4\frac{3}{4}$ mm. or less in length; females 5 mm. or less in length; forks of pygofer hook about equal in length, ventral fork falcate, curved anteriorly; aedeagus short, not extending as far as apex of styles.....(4) *rugosus* n. sp.
Males over $4\frac{3}{4}$ mm. in length, females over 5 mm. in length; forks of pygofer hook usually unequal in length, but if equal, anterior fork not curved anteriorly; aedeagus longer, extending at least as far as apex of styles.... 6

6. (5) Aedeagus with distinct lateral processes near middle and a pair of short processes near apex; forks of pygofer hook long and slender; last ventral segment of female truncate, only slightly, if at all, excavated on sides of the median notch.....(5) *subspinosis* n. sp.
Aedeagus without lateral processes near middle; at least one fork of pygofer hook broad; last ventral segment of female distinctly excavated on sides of median lobe or notch..... 7

7. (6) Apical processes on aedeagus less than $\frac{1}{4}$ length of shaft of aedeagus..... 8
Apical processes on aedeagus over $\frac{1}{4}$ length of shaft of aedeagus..... 10

8. (7) Aedeagus short; ventral fork of pygofer hook with lobe on ventral margin near middle, dorsal fork broadest near base.....(6) *latus* n. sp.
Aedeagus longer; ventral fork of pygofer hook only slightly wider near middle, dorsal fork almost parellel-margined on basal two-thirds..... 9

9. (8) Abdomen with black or fuscous markings; bright yellow to fulvous in color; not southern Arizona.....(7) *aequalis* n. sp.
Abdomen without black or fuscous markings; ivory-white to light yellow in color; southern Arizona.....*equalis ebernus* n. sub sp.

10. (7) Ventral fork of pygofer hook slightly falcate, curved posteriorly; Arizona.....(8) *apicalis* n. sp.
Ventral fork of pygofer hook straight, or if curved, pointed anteriorly; east of Arizona..... 11

11. (10) Males less than 5 mm. in length, females less than $5\frac{1}{2}$ mm. in length; ventral fork of pygofer hook much narrower than dorsal fork; New Mex., western Texas and southeastern Colorado..... 12
Males over 5 mm. in length, females over $5\frac{1}{2}$ mm. in length; ventral fork of pygofer hook about as wide as dorsal; eastern U. S.....(9) *variabilis* n. sp.

12. (11) Tegmen semihyaline fulvous; dorsal fork of pygofer hook about as broad at apical fourth as at base; ventral fork extending almost to margin of pygofer.....(10) *querci* Gillette and Baker
Tegmen semihyaline white to ivory; dorsal fork of pygofer hook distinctly narrower at apical fourth than at base; ventral fork usually extending only about half the distance to margin of pygofer....*querci albus* n. sub sp.

13. (1) Pronotum usually with distinct dark band near posterior margin..... 14
Pronotum without distinct dark band near posterior margin..... 18

14. (13) Tegmen semihyaline fulvous in both male and female, sometimes slightly clouded along margin of clavus.....(11) *tristis* Ball
Tegmen of both male and female not semihyaline fulvous, either opaque or "spotted" with opaque spots..... 15

15. (14) Vertex slightly pointed, male and female the same color; lorae and cheeks usually without darker markings; Southwest.....(12) *prinoides* n. sp.
Vertex parellel-margined; males usually darker than females; lorae and cheeks often with darker markings, especially in the male; eastern and middle western..... 16

16. (15) Vertex and scutellum usually orange; male 5½ mm. or more in length, female 7 mm. or more in length; ventral fork of pygofer hook greatly widened on outer half .....(13) *pediculus* n. sp.
Vertex and scutellum white to yellow; male less than 5½ mm. in length, female less than 7 mm. in length; ventral fork of pygofer hook not greatly thickened on outer half..... 17

17. (16) Lorae and cheeks usually infuscated; dorsal fork of pygofer hook curved abruptly near base.....(14) *pictus* Van Duzee
Only lorae usually infuscated, dorsal fork of pygofer hook not curved abruptly near base.....(15) *slossoni* Van Duzee

18. (13) Tegmen opaque white with two to four dark spots along anterior margin of vertex .....(16) *rubianus* (Ball)
Tegmen not opaque white, or if so, without two to four dark spots along anterior margin of vertex..... 19

19. (18) Pronotum distinctly lighter than tegmen, with markings, if present, indistinct; face yellow with markings, if present, light fulvous..... 20
Pronotum not distinctly lighter than tegmen, or if so, with markings darker and more pronounced; face not yellow with light fulvous markings..... 25

20. (19) General color of tegmen reddish-brown; aedeagus with two pairs of apical processes—one pair directed forward, the other directed backward; Colorado westward 21
General color of tegmen not reddish-brown; aedeagus without two pairs of apical processes; Florida 22

21. (20) Male more than 6 mm. in length, female more than 7 mm. in length; vertex obtusely pointed; ventral fork of pygofer hook longer than dorsal; California .....(17) *subaeneus* (Van Duzee)
Male less than 6 mm. in length, female less than 7 mm. in length; vertex rounded; ventral fork of pygofer hook shorter than dorsal; not California. (18) *glennanus* Ball.

22. (20) Male more than 5 mm. in length, female more than 6 mm. in length; basal two-fifths of ventral fork of pygofer hook much narrower than apical half, 23
Male less than 5 mm. in length, female less than 6 mm. in length; basal two-fifths of ventral fork of pygofer hook not much narrower than apical half, 24

23. (22) Tegmen of male opaque fuscous excepting costal cell; tegmen of female opaque yellow excepting costal cell, with claval suture and anterior margin of clavus brown.....(19) *nitens* Van Duzee
Tegmen of male and female translucent brown except for transparent costal cell .....*nitens pellucidus* n. sub sp.

24. (22) Vertex, pronotum and scutellum clear yellow with no evidence of typical markings except one large faint spot in each basal angle of scutellum; dorsal fork of pygofer hook not curved near base; only one pair of lateral processes near apex of aedeagus.....(20) *flavus* n. sp.
Vertex, pronotum and scutellum ivory-yellow in female, slightly darker in male, with typical markings usually indicated; dorsal fork of pygofer hook curved near base; two pairs of processes near apex of aedeagus, although basal pair often very small.....(21) *parvus* n. sp.

25. (19) Frons of male black with typical markings light, darkest between antennae, frons of female yellow except for chocolate-brown band along base; pygofer hook less than half as long as distance from constriction to apex of pygofer .....(22) *bartschi* Van Duzee
Frons of male and female not as above, or if frons of male as above, pygofer hook longer than half distance from constriction to apex of pygofer..... 26

26. (25) Males 4.2 mm. or less in length; females 5 mm. or less in length..... 27
Males more than 4.2 mm. in length; females more than 5 mm. in length.... 28

27. (26) Processes at apex of aedeagus narrow, less than half as long as shaft of almost straight aedeagus; pygofer hook broadest near middle, split near apex; Tex and Okla.....(23) *minutus* n. sp.
Processes at apex of aedeagus broader, more than half as long as shaft of curved aedeagus; pygofer hook broadest near outer fourth, not split near apex; southeast.....(24) *fulvous* n. sp.

28. (26) Pygofer hook bifid 29
Pygofer hook not bifid 32

29. (28) Ventral fork of pygofer hook greatly broadened on outer half 30
Ventral fork of pygofer hook not much broader on outer half 31

30. (29) Male less than 6 mm. in length, females less than 7 mm. in length; southeast U. S. .....(25) *hibernus* n. sp.
Male 6 mm. or more in length; female 7 mm. or more in length; northeast U. S. .....(26) *borealis* n. sp.

31. (29) Clavus and adjacent area of corium deep fulvous to opaque reddish-brown; dorsal fork of pygofer hook not curved abruptly near base; eastern U. S. .....(27) *luridus* (Van Duzee)
Clavus and adjacent area of corium duller; dorsal fork of pygofer hook curved abruptly near base; western U. S. .....(28) *discolor* n. sp.

32. (28) Processes at apex of aedeagus over half as long as shaft of aedeagus. (29) *southwicki* Van Duzee
Processes at apex of aedeagus distinctly less than half as long as shaft of aedeagus .....(30) *marmoratus* Van Duzee

1. *Eutettix acutus* n. sp.

Similar to *querci*, but slightly larger, usually darker, with a flatter, longer vertex and with one fork of the pygofer hook greatly reduced. Length: Male, 5½ mm.; female, 6½ mm.

Vertex about one and two-thirds times as wide as length at middle, bluntly pointed, transverse furrow shallow; tegmen semihyaline, often darkening posteriorly.

Color: Frons, vertex and scutellum fulvous with typical markings usually absent but occasionally faintly indicated; pronotum slightly darker. Tegmen luteus semihyaline with veins concolorous or darkening posteriorly.

Male genitalia: Pygofer ovate, almost as wide at constriction as length from there to apex; pygofer hook curved dorsally, gradually narrowing to a sharp point, process arising on basal forth about one-fourth length of hook. Aedeagus long and straight, about five times as long as basal width, almost parallel margined throughout, a pair of bifid apical processes about one-third as long as shaft of aedeagus.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior margin almost straight, lateral margins somewhat constricted near middle, broad lobe on lateroposterior corner, posterior margin produced to a pair of lobes separated by a distinct median notch.

Types: Holotype male, allotype female and three pairs of paratypes, Chiricahua Mts., Ariz., July 14, 1938, R. H. Beamer. Paratypes from Arizona as follows: 1 male, Chiricahua Mts., June 9, 1933, 1 male, 1 female, Aug. 8, 1932, 2 males, 1 female, Aug. 10, 1941; 1 female, Chiricahua Nat'l Monument, Aug. 24, 1935; 1 male,

Huachuca Mts., Aug. 22, 1935, 1 male, Aug. 1, 1927, R. H. Beamer; 1 female, Chiricahua Mts., July 14, 1938, R. I. Sailer; 2 males, Chiricahua Mts., July 6, 1930, 1 female, July 27, 1935, 1 female, Sept. 12, 1931; 2 pairs, Faraway Ranch, July 26, 1935; 1 male, Huachuca Mts., July 29, 1935, 1 male, May 4, 1930, E. D. Ball; 1 male, Patagonia, June 24, 1933; 1 male, Carr Canyon, Huachuca Mts., Oct. 31, 1937, P. W. Oman; 1 female, Huachuca Mts., July 20, 1937, 1 female, Sept. 9, 1938; 1 female, Tumacacori Mts., July 21, 1940, D. J. & J. N. Knull. Types in the Kansas University collection and paratypes in this collection, the Ball collection, the Ohio State collection and the National Museum.

2. *Eutettix planus* n. sp.

Resembles *acutus*, but smaller, luteus in color and with one fork of the pygofer hook reduced to a fleshy lobe. Length: Male, 4.75 mm.; female, 5.75 mm.

Vertex about one and two-thirds times as wide as length at middle, bluntly pointed, transverse furrow indistinct; tegmen luteus semihyaline without vermiculations.

Color: Frons, vertex, pronotum and scutellum luteus with typical markings sometimes faintly indicated. Tegmen semihyaline luteus with veins concolorous.

Male genitalia: Pygofer broad, bluntly pointed, about four-fifths as wide at constriction as length from there to apex; pygofer hook with dorsal fork reduced to a fleshy lobe about half as long as ventral fork, which is straight and slightly over half as long as length of pygofer. Aedeagus in lateral view long, about six times as long as basal width, almost parallel-margined on outer three-fourths, a pair of apical, bifurcate processes, each fork over one-third as long as shaft of aedeagus.

Female genitalia: Last ventral segment almost twice as wide as length at middle, lateral margins slightly convex, posterior margin gradually produced to a slightly notched apex.

Types: Holotype male, allotype female and 9 male and 4 female paratypes, Miami, Arizona, July 22, 1932, J. D. Beamer. Paratypes from Arizona as follows: 2 males, 1 female, Miami, July 21, 1932, 6 males, 1 female, Aug. 6, 1941; 1 female, Prescott, July 29, 1933, 1 pair, Yarnell, July 27, 1933, R. H. Beamer; 1 female, Yarnell Hts., Aug. 20, 1929, 1 female, July 21, 1929; 3 males, Pinal Mts., July 18, 1935; 2 pairs, Superior, July 17, 1935; 1 pair, Glenn Oaks, July 19, 1929, 1 male, July 18, 1929, 1 pair, Oct. 7, 1929, E. D. Ball; 1 male,

Prescott N. F., July 14, 1940, D. J. & J. N. Knull. Paratypes from New Mexico: 1 male, Silver City, July 22, 1936, R. H. Beamer. Types in the University of Kansas collection and paratypes in this collection, Ohio State collection, Ball collection and National Museum.

This species and *acutus* approach *Twiningia* in the sharp, flat vertex but the genitalia resemble more nearly other species of *Eutettix*.

3. *Eutettix grandis* n. sp.

Resembles *querci*, but larger, darker and with the forks of the pygofer hook much longer. Length: Male, 6 mm.; female, $6\frac{1}{4}$ mm.

Vertex slightly over twice as wide as length at middle; almost parallel-margined, transverse furrow distinct; tegmen semihyaline with occasional clouded spots, especially in clavus.

Color: Frons and vertex ivory, with a line along transverse furrow and one or two dots inside each eye, fulvous; pronotum fulvous with anterior margin and three longitudinal markings, lighter; scutellum yellow-ivory with a large spot inside each basal angle, darker. Tegmen semihyaline luteus, darker in clavus, veins concolorous to light fulvous.

Male genitalia: Pygofer short, almost as wide at constriction as width from there to bluntly-pointed apex; pygofer hook bifid, dorsal fork slightly shorter, curved ventrally on outer fifth and posteriorly on outer tenth, widening gradually to outer sixth, short recurved spine on anterior margin near sharp apex; ventral fork widest on outer fourth, then narrowing to a sharp apex. Aedeagus in lateral view three times as long as basal width, widest at base, then narrowing to outer third, apex rounded, transparent membrane along dorsal margin extending from base to outer third; a pair of processes about one-half as long as basal width of aedeagus located on outer sixth and with a pair of lateral stylet-shaped processes arising near base, about four-fifths as long as shaft.

Female genitalia: Last ventral segment slightly less than twice as wide as length at middle, anterior margin almost straight, lateral margins almost straight, posterior margin slightly convex with a small lobe on each side of a small median notch.

Types: Holotyes male, allotype female and 7 male and 3 female paratypes, Chiricahua Mts., Ariz., July 14, 1938, R. H. Beamer. Paratypes from Arizona as follows: 1 female, Chiricahua Mts., July 8, 1932; 1 female, Santa Rita Mts., June 12, 1933, 1 male, 2 female, July 17, 1932, R. H. Beamer; 1 female, Chiricahua Mts.,

July 14, 1938, L. W. Hepner; 1 male, Huachuca Mts., July 18, 1938, D. W. Craik; 1 pair, Santa Rita Mts., June, F. H. Snow; 2 male, 1 female, Tuscon, June 30, 1929, 2 male, 1 female, Sept. 29, 1929, 1 pair, June 9, 1929, 1 female, Sept. 1 1929, 1 pair, Oct. 20, 1929, 1 pair, Huachuca Mts., June 15, 1930; 1 female, Chiricahua Mts., July 28, 1935, E. D. Ball; 1 pair, Huachuca Mts., June 11, 1933, P. W. Oman; 1 male, 2 female, Chiricahua Mts., Sept. 14, 1938, 1 male, July 26, 1937; 1 pair Huachuca Mts., Sept. 9, 1938; 1 male, Patagonia, Aug. 20, 1940; 1 female, Tuscon, Aug. 16, 1940, D. J. & J. N. Knull. Types in the University of Kansas collection and paratypes in this collection and in the Ohio State collection, the Ball collection and in the National Museum.

This species differs from any other *Eutettix* in the long, slender forks of pygofer hook and the lateral processes arising from near the base of the aedeagus.

Eutettix rugosus n. sp.

Similar to *querci* but, smaller, with the ventral fork of the pygofer hook curved anteriorly and with the aedeagus thicker and shorter. Length: Male, 4¼ mm.; female, 5 mm.

Vertex slightly over twice as wide as length at middle, almost parallel-margined, transverse furrow shallow; tegmen semihyaline fulvous, slightly clouded near appendix.

Color: Frons, vertex, pronotum and scutellum ivory to bright yellow, pronotum usually slightly darker and typical markings sometimes faintly indicated. Tegmen fulvous to luteus semihyaline with veins concolorous, if darker area present, restricted to appendix.

Male genitalia: Pygofer long-ovate, almost as wide at constriction as length from there to rounded apex; pygofer hook bifid, forks about equal in length, dorsal fork narrowest on outer third, broadest just beyond, apex curved posteriorly, prominent spines at outer fourth on ventral margin; ventral fork slightly falcate, broader than dorsal fork, curved anteriorly, notched along posterior margin. Aedeagus in lateral view barely twice as long as basal width, a pair of triangular lateral processes near apex and a pair of slender apical processes about as long as basal width of shaft of aedeagus; in ventral view, narrowest at base, a pair of triangular processes on outer fourth, apex rounded.

Female genitalia: Last ventral segment over twice as wide as length at middle, anterior margin almost straight, lateral margin

convex, posterior margin excavated on both sides of a prominent unnotched median lobe extending as far posteriorly as the lateral margins.

Types: Holotype male, allotype female and 6 male and 1 female paratypes, Miami, Arizona, July 22, 1932, J. D. Beamer. Paratypes from Arizona as follows: 10 males, 1 female, Miami, July 22, 1932, 1 male, 2 females, Yarnell, July 29, 1933, 1 male, July 25, 1932, 1 pair, July 27, 1933, 1 female, Yavapai Co., July 1, 1929, R. H. Beamer. Types and paratypes in the University of Kansas collection.

5. *Eutettix subspinosus* n. sp.

Resembling *querci*, but larger, brighter yellow, and with forks of pygofer hook much more slender. Length: Male, 5½ mm.; female, 6 mm.

Vertex slightly more than twice as wide as length at middle, almost parallel-margined, transverse furrow shallow; tegmen semihyaline luteus with milky spots present, especially in the clavus.

Color: Frons, vertex and anterior portion of pronotum lemon yellow, pronotum darker along posterior margin; scutellum yellow to orange with typical markings faintly indicated. Tegmen luteus semihyaline with veins concolorous; sometimes faintly clouded with white in clavus and adjacent area of corium.

Male genitalia: Pygofer oval, almost as wide at constriction as length from there to apex; pygofer hook bifid, dorsal fork curved ventrally on basal fourth, widest at base, almost parallel-margined on outer three-fourths to sharp apex, ventral fork almost straight, widest near middle, apex sharp. Aedeagus in dorsal view bifid on outer fifth, about five times as long as basal width, a pair of erect lateral spines near middle and a pair of smaller, lateral, triangular processes near apex.

Female genitalia: Last ventral segment slightly less than twice as wide as length at middle, anterior margin almost straight, lateral margins irregularly convex, posterior margin strongly convex with small median notch.

Types: Holotype male, allotype female and 5 male and 6 female paratypes, Santa Rita Mts., Ariz., July 17, 1932, R. H. Beamer. Paratypes from Arizona as follows: 6 males, Santa Rita Mts., June 12, 1933; 2 males, 4 females, Ruby, July 22, 1938; 3 males, 4 females, Patagonia, June 24, 1933, 1 male, 2 females, Aug. 21, 1935; 1 pair, Baboquivari Mts., July 19, 1932, 3 pairs, Benson, Dec. 21, 1941, R. H. Beamer: 1 male, 4 females, Santa Rita Mts., July 17,

1932, J. D. Beamer; 1 male, Santa Rita Mts., July 19, 1938, R. I. Sailer; 1 male, Atascosa Mts., Sept. 29, 1935, 4 females, Aug. 16, 1935; 1 male, Tucson, Apr. 27, 1930, 1 female, Oct. 20, 1929, 1 female, June 16, 1929; 1 pair, Nogales, Aug. 16, 1937, E. D. Ball; 9 males, 2 females, Santa Rita Mts., June 16, 1933, 7 males, 4 females, June 27, 1933; 3 males, 2 females, Patagonia, June 24, 1933, 1 male, Sasabe, Oct. 17, 1937, P. W. Oman. Types in the University of Kansas collection; paratypes in this collection, E. D. Ball collection and the National Museum. The specimen collected by E. D. Ball at Tucson, Ariz., on April 27, 1930, was labeled "blue oak."

6. *Eutettix latus* n. sp.

Resembles *querci*, but slightly darker and with the forks of the pygofer hook greatly broadened and the aedeagus with shorter apical processes. Length: Male, 5½ mm.; female, 6½ mm.

Vertex slightly over twice as wide as length at middle, slightly pointed, transverse furrow shallow; tegmen fulvous semihyaline, sometimes slightly clouded in appendix and at base of claval veins.

Color: Frons, vertex, pronotum and scutellum yellow in male, ivory in female, markings sometimes lightly indicated, pronotum darkest. Tegmen fulvous semihyaline with numerous milky translucent spots, especially in the female, veins concolorous, rarely darkening posteriorly, sometimes clouded with fuscous at apex of claval veins and in appendix.

Male genitalia: Pygofer bluntly pointed, about three-fourths as wide at constriction as length from there to apex; pygofer hook bifid, both forks directed posteriorly, dorsal fork broadest near base, curved posteriorly just beyond middle, gradually narowing to a sharp point, ventral fork falcate, smaller, broadest near middle, narrowing to a sharp point. Aedeagus in lateral view relatively short, about four times as long as greatest width, gradually narrowed to outer third, slightly broader at apex, a pair of apical processes about as long as narrowest width of aedeagus; in ventral view, parallel-margined to outer fifth, broadest at apex, bifurcate on outer fifth, and with apical processes about as long as width of aedeagus at apex.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior margin almost straight, lateral margins slightly convex, posterior margin deeply excavated on either side of a distinct unnotched median lobe extending slightly further posteriorly than lateral margins.

Types: Holotype male, allotype female and 8 male, 5 female paratypes, Redding, California, June 28, 1935, E. I. Beamer. Paratypes from California as follows: 3 pairs, Redding, June 28, 1935; 1 female, Clayton, July 20, 1935; 1 male, 3 female, Dales, June 28, 1935; 12 male, 15 female, Santa Rosa, Aug. 16, 1938, R. H. Beamer; 3 male, 7 female, Santa Rosa, Aug. 16, 1938; 1 female, Arroyo Seco River, Aug. 8, 1938, L. W. Hepner; 3 male, 2 female, Santa Rosa, Aug. 16, 1938; 6 female, Arroyo Seco River, Aug. 8, 1939, R. I. Sailer; 1 male, Pasadena, July 12, 1931, 1 female, June 21, 1931; 2 female, June 19, 1931; 3 female, Pine Valley, July 6, 1931; 1 pair, Beaumont, June 12, 1931; 1 pair, Lebec, June 25, 1934, 2 male, Medford, Ore., Aug. 26, 1934, 2 pairs, Aug. 12, 1934, E. D. Ball; 8 male, 21 female, Redding, June 28, 1935; 4 male, 1 female, Three Rivers, June 9, 1935; 2 female, Winters, June 26, 1935, P. W. Oman; 1 female, Laguna Mts., July 27, 1940; 1 female, Pinon Flat, Santa Rosa Mts., July 1, 1941, D. J. & J. N. Knull. Types in the Kansas University collection. Paratypes in this collection, Ohio State collection, E. D. Ball collection and National Museum.

7. *Eutettix aequalis* n. sp.

Similar to *querci*, but with ventral fork of pygofer hook larger and directed posteriorly; shorter processes at apex of aedeagus; distribution, Colorado to Arizona. Length: Male, 5 mm.; female, 6 mm.

Vertex about twice as wide as length at middle, almost parallel-margined, transverse furrow distinct; tegmen semihyaline without vermiculations or extra cross veins.

Color: Frons, vertex, pronotum, scutellum and tegmen light yellow to fulvous, vertex and scutellum the same color as the pronotum and tegmen slightly darker; typical markings sometimes faintly indicated; apical cells may be very lightly clouded.

Male genitalia: Pygofer long-ovate, slightly over two-thirds as wide at constriction as length from there to pointed apex; pygofer hook bifid, dorsal fork curved ventrally just beyond middle and posteriorly near outer fifth, gradually broadening from base to outer fifth, apex pointed; ventral fork slightly falcate, widest near middle, apex directed posteriorly. Aedeagus in lateral view extending about as far as apex of styles, narrowest near middle with a pair of short apical processes about as long as greatest width of shaft of aedeagus.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior margin almost straight, lateral margins slightly convex, posterior margin almost straight except for a distinct unnotched median lobe.

Types: Holotype male, allotype female, Glenwood Springs, Colo., Aug. 17, 1929, P. W. Oman. Paratypes: 1 male, Aug. 17, 1929, Glenwood Springs, Colo., L. D. Anderson. 1 female, Glenwood Springs, Colo., Aug. 16, 1936; 3 males, Sloss, Colo., Aug. 17, 1929; 2 males, Oak Creek Canyon, Ariz., Aug. 14, 1927, 1 male, July 31, 1933, 1 female, Aug. 9, 1932; 2 females, Ash Fork, Ariz., Aug. 8, 1932; 2 females, Yarnell, Ariz., July 27, 1933, 1 female, July 25, 1932; 2 females, Prescott, Ariz., July 29, 1933, 1 female, Aug. 7, 1932; 1 pair, Granite Dell, Ariz., July 30, 1933; 2 pairs, Pintura, Utah, Aug. 11, 1929; 5 females, Cedar City, Utah, Aug. 13, 1929; 1 female, Salt Lake City, Utah, July 3, 1931, R. H. Beamer. 1 female, Prescott, Ariz., Aug. 7, 1932, J. D. Beamer. 1 male, Cimarron, Colo., Aug. 22, 1896, 1 female, Trinidad, Colo., July 12, 1899, C. P. Gillette. 1 female, Pintura, Utah, Aug. 11, 1929; 2 males, 1 female, Granite Dell, Ariz., June 29, 1933; 9 males, 13 females, Yarnell Heights, Ariz., June 29, 1933, P. W. Oman. 3 males, Glenn Oaks, Ariz., July 19, 1929, 4 males, 5 females, Oct. 7, 1929, 2 males, 4 females, July 18, 1929; 7 males, 6 females, Granite Dell, Ariz., Oct. 6, 1929, 6 females July 17, 1929; 6 females, Yarnell Heights, Ariz., Oct. 8, 1929, 1 female, Oct. 4, 1929, 2 females, July 21, 1929; 1 female, Grand Canyon, Ariz., Aug. 1, 1930; 2 females, Patogonia, Ariz., July 20, 1930; 1 pair, Cedar, Utah, Sept. 12, 1915; 1 male, Durango, Colo., Aug. 13, 1933, E. D. Ball. 1 male, Richfield, Utah, Sept. 12, 1930, E. W. Davis. 1 male, 5 females, Salt Lake City, Utah, Aug. 27, 1906, 3 females, July 13, 1908, 1 male, 3 females, Aug. 29, 1908; 2 males, 1 female, Palmer Lake, Colo., Sept. 18, 1901; 1 male, Durango, Colo., Aug. 9, 1900; 3 males, Ashfork, Ariz., July 14, 1929; 8 females, Oak Creek Canyon, Ariz., Aug. 15, 1938, 1 male, Aug. 1, 1938, 2 females, July 13, 1940; 1 male, 5 females, Prescott, Ariz., June 8, 1941, 5 males, 1 female, June 2, 1937, 1 male, 15 females, July 14, 1940, 1 male, June 6, 1937, 1 pair, June 20, 1937, 1 female, Aug. 18, 1938, 2 males, 4 females, Lincoln Co., N. M., July 9, 1940, D. J. & J. N. Knull. 1 male, 2 females, Palmer Lake, Colo., 3 males, Granite, Utah, July 4, 1936, 1 male June 24, 1926, 3 males, 1 female, June 26, 1936, 1 male, July 14, 1936, 1 pair, June 15, 1936, 1 male, July 8, 1936, 1 pair, July 17, 1936, 1 female, July 21, 1935, 4 females, July 21, 1935, 2 females, July 15, 1936, 1 female, July 24, 1935, 2 females, July 25, 1935, W. M. Allen. 4 males, 1 female, Big Cottonwood Canyon, Utah, July 13, 1935; 2 females, Granite, Utah, Aug. 6, 1935; 2 males, 1 female, Herriman, Utah, Nov. 3, 1935; 1 male, Santaquin, Utah,

Sept. 15, 1935; 1 male, Salt Lake City, Utah, July 13, 1935; 1 male, Tropic, Utah, Sept. 19, 1935, 1 male, Parley Canyon, Utah, Sept. 6, 1932, G. F. Knowlton. 2 males, Big Cottonwood Canyon, Utah, Aug. 27, 1935, C. J. Sorcenson. 1 male, Ogden, Utah, Sept. 20, 1935, R. C. Roskelley. 1 male, Oak Creek Canyon, Utah, July 16, 1936, L. Jeppsen. Types are in the Kansas University collection and paratypes are in this collection and the Colorado State, Utah State, Ohio State and E. D. Ball collections and the National Museum.

This species replaces *querci* west of the continental divide and east of California. There is some variation in the shape of the pygofer hooks of the specimens from Colorado, Utah, and Arizona, but all are undoubtedly the same species. Gillette and Baker's *querci* types from Glenwood Springs, Colorado, were probably this species, but all of them apparently have been lost.

Eutettix aequalis eberneus n. sub sp.

Similar to *aequalis,* but slightly smaller, much lighter in color, aedeagus slightly shorter and with the dorsal fork of the pygofer hook almost straight. Length: Male, 4¾ mm.; female, 5½ mm.

Vertex about twice as wide as length at middle, almost parallel-margined, transverse furrow distinct; tegmen ivory white to light fulvous semihyaline without clouded areas.

Color: Frons, vertex, scutellum and pronotum ivory white to light fulvous, brightest in males; markings on scutellum sometimes faintly indicated. Tegmen semihyaline light fulvous with veins concolorous, occasionally slightly darkened in appendix and adjacent apical cell. Abdomen without darker markings.

Male genitalia: Pygofer long, about three-fifths as wide at constriction as length from there to pointed apex; pygofer hook bifid, dorsal fork almost parallel-margined to outer fifth, apex pointed; ventral fork falcate, broadest near middle, apex pointed. Aedeagus in lateral view short, about four times as long as greatest width, narrowest just beyond middle and broadest near base and apex, a pair of apical processes about as long as average width of aedeagus; in ventral view bifurcate on outer fifth, almost twice as wide at apex as at base, gradually broadening from base to apex, processes hidden.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior margin almost straight, posterior margin excavated on both sides of a prominent unnotched median lobe.

Types: Holotype male, allotype female and 4 male and 10 female

paratypes, Tombstone, Ariz., July 16, 1936, E. D. Ball. Additional paratypes as follows: 6 male, 1 female, Tombstone, Ariz., June 9, 1936, E. D. Ball, all in the E. D. Ball collection at the National Museum.

This species may be separated externally from *querci albus* by the absence of any darker markings on the abdomen.

8. *Eutettix apicalis* n. sp.

Resembles *querci*, but slightly smaller and luteus in color; ventral fork of pygofer hook curved anteriorly. Length: Male, 5 mm.; female, 5.25 mm.

Vertex about twice as wide as length at middle, almost parallel-margined to slightly pointed, transverse furrow usually distinct; tegmen luteus semihyaline except for occasionally a lightly clouded area in appendix.

Color: Frons, vertex, pronotum and scutellum bright yellow to luteus with typical markings sometimes lightly indicated. Tegmen semihyaline luteus to fulvous with veins concolorous, sometimes apices slightly clouded.

Male genitalia: Pygofer long, about two-thirds as wide at constriction as length from there to pointed apex; pygofer hook bifid, dorsal fork slightly longer, widest on outer fourth, curved ventrally just beyond middle, and posteriorly on outer fifth; ventral fork falcate, almost parallel-margined near middle, then tapering to a sharp apex. Aedeagus in lateral view reaching as far as apex of style, about four times as long as greatest width, widest at base, and almost parallel-margined on outer third; a pair of apical processes about one-third length of aedeagus.

Female genitalia: Last ventral segment about twice as wide as length at middle, posterior margin almost straight, lateral margins slightly convex, rounded on lateroposterior corner, posterior margin excavated on both sides of a prominent unnotched median lobe extending further posteriorly than the lateral margins.

Types: Holotype male, allotype female and 7 pairs of paratypes, Chiricahua Mts., Ariz., July 14, 1938, R. H. Beamer. Paratypes from Arizona as follows: 2 male, 2 female, Chiricahua Mts., July 8, 1932, 7 male, 1 female, Aug. 7, 1941, 1 female, June 9, 1933, 2 female, Aug. 7, 1941; 1 female, Chiricahua Nat'l Monument, Aug. 24, 1935; 1 male, Sunnyside Canyon, Huachuca Mts., July 9, 1940, R. H. Beamer; 1 male, 1 female, July 14, 1938, R. I. Sailer; 1 female, Chiricahua Nat'l Monument, Aug. 24, 1935, Jean Russell; 4 male, 4 female, Chiricahua Mts., July 6, 1930; 3 male, 1 female, Faraway

Ranch, July 26, 1935, E. D. Ball; 2 male, 1 female, Chiricahua Mts., June 15, 1939, 1 male, Sept. 14, 1938, 1 female, July 26, 1937, D. J. & J. N. Knull. Types in the Kansas University collection and paratypes in this collection and the Ohio State and E. D. Ball collections.

9. *Eutettix variabilis* n. sp.

Resembling *querci,* but luteus, darker in the male; pygofer more sharply pointed and dorsal fork strongly curved just beyond middle. Length: Male, 5½ mm.; female, 6½ mm.

Vertex about twice as wide as length at middle, almost parallel margined, transverse furrow usually distinct; tegmen semihyaline luteus.

Color: Frons, vertex, pronotum, and scutellum light yellow to luteus in female, much brighter in the males, typical markings sometimes present. Tegmen of female light luteus; of male, dark luteus, veins concolorous.

Male genitalia: Pygofer long, two-thirds as wide at constriction as length from there to pointed apex; pygofer hook bifid, dorsal fork curved ventrally just beyond middle and curved posteriorly near apex, ventral fork barely reaching to margin of pygofer, straight or slightly curved anteriorly. Aedeagus long, about six times as long as greatest width, widest near base, but almost parallel-margined throughout its length, a pair of apical processes about one-third length of shaft; in ventral view, parallel-margined, bifid on outer sixth.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior margin almost straight, lateral margins slightly produced near middle, posterior margin excavated on both sides of a notched or unnotched median lobe.

Types: Holotype male, allotype female and 3 male and 1 female, Fayetteville, Arkansas, 1938, M. W. Sanderson; Paratypes as follows: 32 male, 6 female, Washington Co., Ark., June 30, 1940, M. W. Sanderson. Types and paratypes in the Kansas University collection.

10. *Eutettix querci* Gillette & Baker

Eutettix querci, Gillette & Baker, Hemiptera of Colorado, p. 101, 1895.

Resembling *apicalis,* but fulvous in color and with the ventral fork of the pygofer hook straight and reduced. Length: Male, 4¾ mm.; female, 5½ mm.

Vertex about twice as wide as length at middle, transverse furrow distinct; tegmen fulvous semihyaline with veins darkening posteriorly in the male and almost opaque in the female.

Color: Frons, vertex, pronotum and scutellum yellow-green in the male, fulvous in the female, typical markings sometimes indicated; tegmen semihyaline fulvous in the male with veins darkening posteriorly, more opaque in the female and with a slightly greenish color.

Male genitalia: Pygofer long-ovate, about three-fourths as wide at constriction as length from there to rounded apex; pygofer hook bifid, dorsal fork about twice as long as ventral, almost parallel-margined to outer fourth, curved ventrally on outer fourth and posteriorly on outer fifth, prominent teeth along ventral margin; ventral fork slender and straight to a pointed apex. Aedeagus in lateral view about six times as long as greatest width, almost parallel-margined throughout; a pair of apical processes about one-third length of shaft; in ventral view parallel-margined and bifid on outer sixth.

Female genitalia: Last ventral segment about twice as wide as length at middle, posterior margin almost straight, lateral margins somewhat convex, posterior margin excavated on both sides of a prominent, unnotched median lobe.

Types: Lectotype female, Manitou, Colorado, Sept. 29, 1894, C. P. Gillette, (swept from *Quercus undulata)* in the Colorado State collection. This species was described from one male and nine females collected at Manitou, Colorado and Glenwood Springs, Colorado. The specimens collected at Glenwood Springs were evidently *aequalis*, since *querci* does not extend that far west. The only specimen of this series that I was able to locate was the one female cotype in the Colorado State collection, which I here designate lectotype. In case the other co-types are lost, I designate as a neotype a male specimen collected at Trinidad, Colorado, July 13, 1890, in the Colorado State collection. Specimens of this species were examined from Santa Rosa, N. Mex., Cimarron, N. Mex., Clouderoft, N. Mex., Colfax Co., N. Mex., Davis Mts., Tex., Montezuma Co., Colorado and Durango, Colorado.

Eutettix querci albus n. sub sp.

Similar to *querci*, but white to ivory in color and with the ventral fork of the pygofer hook somewhat more reduced. Length: Male, 4.75 mm.; female, 5.25 mm.

Vertex about twice as wide as length at middle, slightly more pointed than *querci,* transverse furrow distinct; tegmen hyaline to opaque white to ivory.

Color: Frons, vertex, pronotum and scutellum yellow to greenish-

yellow in the male, white to ivory in the female, typical markings on the scutellum sometimes present. Tegmen white to ivory, semihyaline in the male, more opaque in the female with veins usually darkened posteriorly, especially in the male.

Male genitalia: Pygofer long, about two-thirds as wide at constriction as length from there to pointed apex; pygofer hook bifid, dorsal fork over twice as long as ventral, almost parallel margined to outer fifth, where it curves abruptly posteriorly; ventral fork straight, narrow and sharply pointed. Aedeagus in lateral view about six times as long as basal width, almost parallel-margined for the entire length of the shaft, a pair of apical processes about one-third length of shaft; in ventral view, parallel-margined and slightly bifid at apex.

Female genitalia: Last ventral segment about twice as wide as length at middle, posterior margin almost straight, lateral margins faintly sinuate, rounded on lateroposterior corner, posterior margin excavated on both sides of a prominent unnotched median lobe extending further posteriorly than the lateral margins.

Types: Holotype male, allotype female and 8 male and 17 female paratypes, Kenna, N. Mex., Aug. 9, 1941, R. H. Beamer. Additional paratypes as follows: 2 pairs, Kenna, N. Mex., Aug. 9, 1941, B. Hodgden, 2 pairs, July 16, 1936, D. R. Lindsay; 6 males, 7 females, Shamrock, Tex., Aug. 10, 1941, R. H. Beamer, 2 pairs, Aug. 10, 1941, E. L. Todd. Types in the Kansas University collection.

This species is separated from *aequalis eberneus* by a more easterly distribution, presence of fuscous markings on the abdomen and longer apical processes on the aedeagus. It differs from *querci* by being lighter in color and with a shorter ventral fork on the pygofer hook. The specimens collected by R. H. Beamer Aug. 9, 1941, at Shamrock, Tex., were collected on *Quercus prinoides*.

11. *Eutettix tristis* Ball

Eutettix subaenea var *tristis*, Ball, Proc. Dav. Acad. Sci., xii, p. 34.

Similar to *pictus*, but lighter in color, without the dark markings on cheeks and with dorsal fork of pygofer hook extending as far as ventral. Length: Male, 5½ mm.; female, 6½ mm.

Vertex over twice as wide as length at middle, almost parallel-margined, transverse furrow shallow; tegmen semihyaline fulvous throughout.

Color: Frons yellow with two large basal spots, black, oblique markings sometimes faintly indicated, vertex yellow with two large dark spots along anterior margin, usually separated by a narrow

yellow line, pronotum yellow except for wide fulvous to fuscous band usually covering most of posterior half, lighter in female; scutellum yellow to fulvous with typical markings sometimes present. Tegmen semihyaline fulvous with white spots at apex of clavus at least indicated, usually darkened on both sides of this spot, veins usually concolorous but may darken posteriorly, apical cells sometimes slightly infuscated.

Male genitalia: Pygofer slightly over one-half as wide at constriction as length from there to pointed apex, pygofer hook bifid, dorsal fork "gooseneeked" near base, widest near middle, apex pointed, ventral fork widest near base, extending about as far as dorsal, pointed at apex. Aedeagus in lateral view slightly over three times as long as greatest width, almost parallel-margined to outer third, narrowing to a bluntly pointed apex, a pair of short processes on dorsal margin near apex.

Female genitalia: Last ventral segment slightly less than twice as wide as length at middle, almost straight along anterior and lateral margins, posterior margin almost straight except for large unnotched median lobe.

Type: A specimen of this species in the National Museum bears Ball's name label and is designated as lectotype. It is a female labeled "Jacksonville, Fla." and has a small "TYPE" on the pin. In the original description no specimen is named as a type.

Material examined: Specimens are on hand from Florida, Louisiana, South Carolina, Georgia, Maine, Illinois and Kansas so that one might say that this species may be found in most of the eastern part of the United States.

Occasionally specimens of this species may have the band on the pronotum very light or indistinct, but the large pair of dark markings at apex of vertex readily separates this species from *marmoratus,* which it resembles in having semihyaline fulvous tegmen.

12. *Eutettix prinoides* n. sp.

Resembles *slossoni,* but with vertex slightly pointed, with males and females the same color, with forks of pygofer hook longer and home slender; more western in distribution. Length: Male, 5 mm.; female, 6 mm.

Vertex about twice as wide as length at middle, obtusely pointed, transverse furrow shallow; tegmen semihyaline, approaching opaqueness in clavus and spots in corium.

Color: Face yellow with two black spots at base extending from ocelli to center, separated by a narrow yellow line; vertex yellow

except for two large black spots along anterior margin; pronotum gray to yellow except for broad brown band near posterior margin and a small brown dot at middle of anterior margin; scutellum ivory white to yellow with typical markings sometimes faintly indicated. Tegmen semihyaline to opaque fulvous in the clavus and adjacent area of corium, a large white spot near apex of clavus; margin of clavus, a spot in discal cell and in each anteapical cell and sometimes apical cells, infuscated. In some specimens the white in the tegmen is replaced by yellow.

Male genitalia: Pygofer about one half as wide at constriction as length from there to bluntly pointed apex; pygofer hook bifid, forks about equal in length, dorsal fork "goosenecked" near base, slightly broadest on outer half to pointed apex, ventral fork slightly broader than dorsal. Aedeagus in lateral view about five times as long as greatest width, broadest near middle, narrowing to a rounded apex, a pair of short processes on dorsal margin on outer fifth; in ventral view, bifid on outer two-fifths and a pair of short lateral processes on outer third.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior margin almost straight, lateral margins slightly convex, posterior margin excavated on each side of a distinct unnotched median lobe extending slightly further posteriorly than lateral margins.

Types: Holotype male, allotype female and 16 male and 13 female paratypes, Shamrock, Texas, Aug. 10, 1941, R. H. Beamer. Paratypes as follows: 9 male, 3 female, Shamrock, Tex., Aug. 10, 1941, E. L. Todd; 2 male, 1 female, Kenna, N. Mex., July 16, 1936, D. R. Lindsay; 1 male, 2 female, Kenna, N. Mex., July 16, 1936; 1 male, 2 female, Sutton Co., Tex., July 16, 1928; 1 female, Ozona, Tex., July 9, 1936; 1 female, Kendall Co., Tex., July 22, 1928; 1 female, Concan, Tex., July 6, 1936; 1 female, San Antonio, Tex., July 4, 1936, R. H. Beamer; 3 male, 14 female, Concan, Tex., June 4, 1933, P. W. Oman. Types in the University of Kansas collection and paratypes in this collection and in the National Museum.

This species was collected at Shamrock, Tex., on *Quercus prinoides* by R. H. Beamer.

13. *Eutettix pediculus* n. sp.

Resembles *pictus,* but larger, approaching orange in color except on tegmen and with the ventral fork of the pygofer hook much narrower on basal half than on apical half. Length: Male, 5.75 mm.; female, 7 mm.

Vertex about twice as wide as length at middle, almost parallel-margined, transverse furrow shallow; tegmen varying from opaque along margin of clavus to transparent along costal margin.

Color: Frons, vertex, pronotum and scutellum yellow to orange, except for following fuscous markings: A spot on disc of frons; two large spots enclosing both ocelli, covering anterior half of vertex and basal portion of frons, separated mesally by a narrow light line; broad band across posterior half of pronotum. Markings on scutellum sometimes lightly indicated. Cheeks and lorae may or may not be darkened. Clavus and adjacent area of corium and apical cells opaque black, costal cell transparent.

Male genitalia: Pygofer about two-thirds as wide at constriction as length from there to pointed apex; pygofer hook bifid, dorsal fork curved abruptly near base, almost parallel-margined to pointed apex; ventral fork narrowest on basal third, much broader near middle, pointed at apex. Aedeagus in lateral view about six times as long as greatest width, almost parallel-margined on basal three-fifths, gradually narrowing to a rounder apex, a pair of short processes on dorsal margin near apex.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior and lateral margins almost straight, lateral margins slightly converging posteriorly, posterior margin almost straight except for distinct unnotched median lobe.

Types: Holotype male, allotype female and 1 male and 2 female paratypes, Clarksville, Tenn., July 22, 1915, 1 male, Woodville, Miss., July 25, 1921, C. J. Drake; 1 male, Coffeyville, Kansas, July 4, 1939, 1 female, July 25, 1939, L. W. Hepner; 1 female, Elk City, Kansas, July 3, 1926, Beamer & Lawson; 1 male, Hilliard, Fla., Aug. 31, 1930, R. H. Beamer; 1 male, Caddo Parish, La., Aug. 19, 1928, Jack Beamer; 1 pair, Thebes, Ill., July 11, 1935, LeLong & Ross; 1 male, Elizabethtown, Ill., July 8, 1935, Ross & DeLong; 1 male, Rosiclare, Ill., July 5, 1935, Frison & Mohr.

This species resembles *pictus* externally, but the genitalia resembles more nearly that of *nitens*.

14. *Eutettix pictus* Van Duzee

Eutettix pictus, Van Duzee, Trans. Am. Ent. Soc., xix, p. 301, 1892.

Eutettix magnus, Osborn, Ent. News, xi, p. 395, 1900.

Resembles *slossoni*, but larger, darker, with the cheeks beyond lorae usually infuscated and with the dorsal fork "goosenecked" near base. Length: Male, 5 mm.; female, 6½ mm.

Vertex slightly over twice as wide as length at middle, almost

parallel-margined, transverse furrow indistinct; tegmen varying from semihyaline along costal margin to opaque in clavus.

Color: Frons of female yellow with the base dark, of male, yellow with base dark and markings on disc, fuscous to black; lorae and adjacent area of cheeks usually infuscated; vertex, pronotum and scutellum yellow to orange, darkest in the male with apical half of pronotum and a broad band on posterior half of pronotum, brown to black. Tegmen with white opaque spot near apex of clavus; clavus and adjacent half of corium brown to fuscous, darkest along margin of clavus and in discal cell; remainder of wing fulvous semihyaline except for infuscated apical cells.

Male genitalia: Pygofer slightly over half as wide at constriction as length from there to pointed apex; pygofer hook bifid with ventral fork pointed, broader than dorsal and extending slightly farther than dorsal, widest on outer third, dorsal fork "goosenecked" near base, gradually broadening to outer third, apex pointed. Aedeagus in lateral view slightly over four times as long as greatest width, largest near middle, narrowing to a bluntly pointed apex, a pair of short processes on dorsal margin near apex.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior and lateral margins almost straight, posterior margin shallowly excavated on each side of a prominent unnotched median lobe.

Types: Holotype female, Pennsylvania, C. W. Johnson, in the Iowa State collection, Ames, Iowa. The allotype male of *magnus*, Morgan Co., Ill., June 29, 1892, F. M. McElfresh, in the Ohio State collection, Columbus, Ohio.

Specimens are on hand from most of the eastern half of the United States from Florida to Texas on the south and from Wisconsin to Pennsylvania on the north. The specimens from the southern part of this area are smaller than those from points farther north. As a rule, both the male and female have the checks somewhat infuscated, but occasionally an entire series is found in which this marking is absent in the female. The "goosenecked" basal portion of the dorsal fork of the pygofer hook readily separates this species from *slossoni*, while its color is much darker than *tristis*.

15. *Eutettix slossoni* Van Duzee

Eutettix slossoni, Van Duzee, Bull. Soc. Nat. Sci., v. p. 210, 1894.

Similar to *tristis*, but smaller, more darkly colored and with the dorsal fork of the pygofer hook without the gooseneck near base. Length: Male, 4 mm.; female, 5 mm.

Vertex about twice as wide as length at middle, almost parallel-margined, transverse furrow almost absent; tegmen varying from semihyaline in females to opaque in males.

Color: Frons of female yellow with two large apical spots, fuscous; of male, black with typical markings yellow; vertex, pronotum and scutellum yellow with two large spots on anterior margin of vertex and band across posterior part of pronotum, brown to black. Tegmen of female semihyaline light fulvous with veins darkening posteriorly and darkened along outer margin of clavus, in apical cells, and in center of discal cell; males opaque black in clavus and adjacent area of corium, outer half of corium partly semihyaline and partly opaque, both sexes have distinct white spot at apex of clavus.

Male genitalia: Pygofer slightly over one-half as wide at constriction as length from there to sharp apex, pygofer hook bifid with forks about equal in width, but with ventral fork usually slightly longest and with no gooseneck near base of dorsal fork. Aedeagus in lateral view slightly over three times as long as greatest width, slightly widest near middle, narrowing to a bluntly pointed apex, a pair of short processes on dorsal margin near apex; in ventral view, bifid on outer half.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior and lateral margins almost straight, posterior margin excavated on each side of a prominent, unnotched median lobe, which extends slightly further posteriorly than the rounded lateroposterior corner.

Types: Holotype female, Charlotte Harbor, Florida, Annie Trumbull Slosson in the Iowa State collection, Ames, Iowa; allotype male, labeled "Florida" here designated, in the Iowa State collection.

Material examined from Florida: Hilliard, Suawnee Springs, Lachooche, Tampa, Hiberia, La Belle, Cedar Keys, Zolpho Springs, Hudson and Duval Co.

16. *Eutettix rubianus* (Ball)

Ollarianus rubianus, Ball, E. D., Jour. Wash. Acad. Sci., v. xxvi, p. 432, 1936.

Resembling *subaeneus*, but shorter, tegmen opaque ivory-grey, black spots along anterior margin of vertex and with dorsal fork of pygofer hook bifid at apex. Length: Male, 5½ mm.; female, 6 mm.

Vertex about three times as wide as length at middle, almost parallel-margined, transverse furrow distinct, tegmen opaque with veins darker.

Color: Frons light yellow with typical markings fulvous; vertex

ivory-yellow with one or two marks inside each eye, fulvous, a spot just above each ocellus and a pair of lines near apex, black; pronotum ivory-grey, lightest along anterior margin with four pairs of spots sometimes evident; scutellum ivory-yellow with typical markings yellow to light fulvous except for a black dot along each lateral margin. Tegmen opaque ivory-grey with veins brown.

Male genitalia: Pygofer long, slightly over one-half as wide at constriction as length from there to pointed apex, pygofer hook bifid, dorsal fork curved and parallel-margined on basal two-thirds, split at apex with two sharp points, ventral fork straight, about as long as dorsal, broadest near outer third, a small process on dorsal margin near middle, apex pointed. Aedeagus in lateral view about five times as long as greatest width, slightly narrowed from bas to apex, a pair of narrow erect apical processes about one-fourth length of shaft of aedeagus and a pair of broader processes about one-half length of shaft, directed anteriorly.

Female genitalia: Anterior margin of last ventral segment almost straight, lateral margins somewhat convex, posterior margin rounded marginally, slightly excavated on each side of a distinct, unnotched median lobe.

Types: Holotype female, Atascosa Mt., Ariz., Nov. 3, 1935, E. D. Ball, in the National Museum, Washington, D. C.

Material studied: Specimens studied from Atascosa Mt., Ariz., in April and May, 1936.

17. *Eutettix subaeneus* (Van Duzee)

Thamnotettix subaeneus, Van Duzee, Ent. Am., vi, p. 77, 1890.

Resembles *luridus*, but much longer, narrower and aedeagus with two pairs of apical processes; Pacific coast species. Length, 6 mm., 7 mm.

Vertex about twice as wide as length at middle, bluntly pointed, transverse furrow distinct; tegmen fulvous semihyaline with occasional clouded areas.

Color: Frons, vertex, pronotum and scutellum ivory-yellow with typical markings usually lightly indicated. Tegmen semihyaline fulvous with veins darkening posteriorly, somewhat clouded at ends of claval veins, in discal cell, middle anteapical cell and in apical cells.

Male genitalia: Pygofer slightly over half as wide at constriction as length from there to bluntly pointed apex; pygofer hook bifid, ventral fork longest, curved posteriorly, narrowing gradually to a sharp apex, dorsal fork curved ventrally on basal third, parallel-

margined on basal half, then narrowing gradually to a sharp point. Aedeagus in lateral view about six times as long as basal width, gradually narrowing to a bluntly pointed apex with two pairs of apical processes, one erect pair, one-fourth length of shaft, projecting anteriorly and the other pair, one-third length of shaft, largest near middle, projecting posteriorly.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior margin almost straight, lateral margins, slightly convex and converging, posterior margin almost straight except for a distinct unnotched median lobe.

Types: Lectotype male, allotype female, Cal., Coquillet, in the Iowa State collection, Ames, Iowa.

Material on hand from California is as follows: Alpine, Lompoc, Miramar, San Antonio Canyon, San Diego, Stinson Beach, Santa Cruz Mts., Irvine Park, Jamesburg, Monterey, Los Angeles and Taylorville. There is also one male specimen from Pendleton, Oregon.

This species and *latus* are the only ones in the genus found in California. *E. subaeneus* is easily separated from *latus* by the darker color of the tegmen and the pointed vertex.

18. *Eutettix glennanus* Ball

Eutettix glennanus, Ball, E. D., Fla. Int., xv. p. 2, 1931.

Resembles *subaeneus,* but smaller, with the vertex rounded and sometimes with two to four black spots along margin of vertex present, forks of pygofer hook almost equal in length. Length: Male, 5 mm.; female, 6½ mm.

Vertex almost three times as wide as length at middle, almost parallel-margined, transverse furrow distinct; tegmen semihyaline fulvous irregularly clouded with opaque fulvous markings.

Color: Frons light fulvous with typical markings absent or slightly darker; vertex light fulvous with two spots just inside each eye and line along transverse furrow, slightly darker, a spot just above each ocellus and a pair near apex, fuscous or fulvous; pronotum greyish-fulvous, lightest along anterior margin where four pairs of fulvous spots are sometimes present; scutellum ivory to light fulvous with two black dots along lateral margins usually present, other typical markings sometimes dark fulvous. Tegmen semihyaline light fulvous, with some clouded areas present, veins dark fulvous, commissural spot present.

Male genitalia: Pygofer ovate, about three-fourths as wide at constriction as length from there to broadly pointed apex; pygofer

hook bifid, both forks about the same width and extending just beyond margin of pygofer, dorsal fork curved ventrally near basal fourth, almost parallel-margined to sharp apex, ventral fork straight or slightly curved anteriorly. Aedeagus in lateral view slender, about six times as long as greatest width, gradually narrowing from base to apex, two pairs of slender apical processes, one pair, about one-third length of shaft, directed anteriorly and the other, about one-half length of shaft, directed posteriorly.

Female genitalia: Last ventral segment slightly less than twice as wide as length at middle, anterior margin almost straight, lateral margins rounded evenly to convex posterior margin, distinct unnotched median lobe.

Types: Holotype female, allotype male and 1 female paratype, Glenn Oaks, Ariz., Oct. 7, 1929, E. D. Ball.

Material examined: (Arizona) Huachucua Mts., Patagonia, Tucson, Santa Rita Mts., Hualpai Mt., Pinaleno Mt., (Colorado) Fort Collins, Poudre River Canyon, Montezuma Co. (Utah) St. George, (Texas) Davis Mts.

Specimens of this species from Colorado are larger and have been confused with *subaeneus* and *luridus*. The type material, collected in the fall, has the dark markings along the anterior margin of the vertex. However, specimens collected in the summer usually lack these markings.

19. *Eutettix nitens* Van Duzee

Eutettix nitens, Van Duzee, Bull. Buff. Soc. Nat. Hist., ix, 223, 1909.

Resembles *luridus*, but with tegmen of male opaque black and clavus of female opaque fulvous to yellow; ventral fork of pygofer hook with slender basal pedicel. Length: Male, 5½ mm.; female, 6 mm.

Vertex over twice as wide as length at middle, almost parallel-margined, transverse furrow shallow; tegmen varying from fulvous semihyaline in corium of female to opaque black in male.

Color: Frons, vertex, pronotum and scutellum ivory to bright yellow without color markings. Tegmen of female fulvous semihyaline in corium, becoming opaque in clavus, opaque yellow spot near apex of clavus, brown along anterior margin of clavus, along claval suture, on apical cells and often spots in corium; of male, opaque brown to black, becoming semihyaline along costal margin.

Male genitalia: pygofer long, slightly over one-half as wide at constriction as length from there to pointed apex; pygofer hook bifid, ventral fork slightly longest, very narrow on basal two-fifths, widest

slightly beyond middle, gradually narrowing to a sharp point, dorsal fork curved near base, widest on outer third, pointed. Aedeagus in lateral view about four times as long as greatest width, largest near middle, narrowing to a bluntly pointed apex, a pair of very short processes on dorsal margin on outer fifth.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior margin almost straight, lateral margins convex, slightly converging; posterior margin slightly convex on both sides of an unnotched median lobe.

Types: I was unable to locate the types of this species, but cotypes of *bartschi*, described at the same time, are in the California Academy Science Museum so the types of this species may also be there. The species was described from various localities in Florida.

Material studied: (Florida) Sanford, St. Augustine, Hobe Sound, Cold, Hudson, Palm Beach, Branford, La Belle, Cedar Keyes and Inverness.

Eutettix nitens pellucidus n. sub sp.

Similar to *nitens*, but smaller and with tegmen semihyaline fulvous. Length: Male, 5 mm.; female, 5½ mm.

Vertex almost three times as wide as length at middle, almost parallel-margined, transverse furrow shallow; tegmen semihyaline, approaching translucency in clavus.

Color: Frons, vertex, pronotum and scutellum fulvous-yellow, markings on scutellum sometimes faintly indicated. Tegmen translucent fulvous in clavus and adjacent area of corium; remainder of tegmen semihyaline fulvous, darkest along outer margin of clavus except for distinct yellow commissural spot near apex of clavus.

Male genitalia: Pygofer about three-fifths as wide at constriction as length from there to pointed apex; pygofer hook bifid, dorsal fork slightly shortest, curved ventrally near base, gradually narrowing to pointed apex; ventral fork narrowed on basal two-fifths, broadest near middle, narrowing gradually to a sharp apex. Aedeagus in lateral view about five times as long as greatest width, broadest near middle, narrowing to a bluntly pointed apex, a pair of short processes on dorsal margin at outer fifth, in ventral view, bifid on outer third.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior margin almost straight, lateral margins slightly convex, posterior margin almost straight on each side of a distinct unnotched median lobe.

Types: Holotype male, allotype female and 1 pair of paratypes,

Ocala, Florida, Aug. 13, 1926, E. D. Ball. Additional paratypes from Florida as follows: 1 female, Ocala, Aug. 14, 1926, 3 males, 2 females, Nov. 6, 1927; 1 pair, Apopka, Aug. 14, 1926; 1 pair, Jacksonville, May 8, 1927; 1 pair Sanford, July 3, 1926, 1 female, Sept. 2, 1926, 1 male, 2 females, May 30, 1926, 1 pair, Apr. 30, 1926, E. D. Ball; 1 male, Coconut Grove, Aug. 9, 1930, L. D. Tuthill.

20. *Eutettix flavus* n. sp.

Resembles *nitens*, but smaller with tegmen fulvous to golden in both male and female; ventral fork of pygofer hook not greatly compressed near base. Length: Male, 4½ mm.; female, 5¼ mm.

Vertex slightly over twice as wide as length at middle, almost parallel-margined, transverse furrow shallow; tegmen semihyaline to translucent, becoming almost transparent along costal margin.

Color: Frons, vertex, pronotum and scutellum yellow to fulvous with markings, if present, faintly indicated. Tegmen fulvous, varying from translucent in the clavus to almost transparent along the costal margin, veins in apical third of wing distinct; commissural spot present near apex of clavus.

Male genitalia: Pygofer about two-thirds as wide at constriction as length from there to pointed apex; pygofer hook bifurcate, both forks straight and about equal in length and width. Aedeagus in lateral view about five times as long as greatest width, broadest near middle, narrowing to a rounded apex, a pair of short, erect processes on dorsal margin near apex, on ventral margin bifid on outer third.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior margin almost straight, lateral margins slightly convex, posterior margin excavated on both sides of a median unnotched lobe that extends about as far posteriorly as the latero-posterior corners.

Types: Holotype male, allotype female and 2 male and 3 female paratypes, Likely, Florida, July 24, 1934, R. H. Beamer. Additional paratypes from Florida as follows: 1 male, Lake Jovita, July 20, 1934, R. H. Beamer; 1 male, Sanford, Aug. 22, 1933, C. O. Bare; 6 male, 4 female, Sanford, July 22, 1926, 1 female, May 28, 1926, 4 female, June 22, 1926, 2 female, Oct. 7, 1926, 1 female, July 3, 1926, 1 male, 2 female, Oct. 24, 1926, 1 female, Apr. 28, 1926, 3 male, Nov. 3, 1925, 1 male, Jan. 15, 1926, 1 female, Feb. 15, 1926, 4 pairs, Aug. 4, 1926, 3 female, July 1, 1926, 2 female, June 16, 1926, 2 male, 3 female, July 4, 1926, 2 female, Aug. 17, 1926, 2 female, Sept. 27, 1926, 1 female, May 19, 1926, 1 male, 2 female, Sept. 9, 1926, 1

female, Jan. 21, 1926, 1 male, May 28, 1926, E. D. Ball; 4 male, 8 female, Sanford, July 22, 1939, P. W. Oman. Types in the Kansas University collection; paratypes in this collection, the E. D. Ball collection and National Museum.

This species was listed by Doctor Ball as *E. bartschi*, but it differs from that species in the coloration of the frons as well as in the genital characters.

21. *Eutettix parvus* n. sp.

Resembles *nitens*, but smaller, lighter in color with typical markings usually evident, and without ventral fork of pygofer hook greatly narrowed at base. Length: Male, 4½ mm.; female, 5½ mm.

Vertex slightly over twice as wide as length at middle, almost parallel-margined, transverse furrow distinct; tegmen semihyaline fulvous.

Color: Frons, vertex, and scutellum ivory white to yellow, brightest in male, markings usually evident; pronotum darker than vertex in male, concolorous in female. Tegmen semihyaline fulvous in male, translucent fulvous in female, veins sometimes darkening posteriorly; margin of clavus darkened, except for commissural spot near apex.

Male genitalia: Pygofer long-ovate, about two-thirds as wide at constriction as length from there to rounded apex; pygofer hook bifid, both forks about equal in length, dorsal fork curved abruptly near base, almost parallel-margined to pointed apex, ventral fork parallel-margined on basal half, widest on outer fourth, pointed. Aedeagus in lateral view about four times as long as greatest width, slightly broadest near middle, narrowing to a rounded apex; in ventral view, bifid on outer third.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior margin almost straight, lateral margins slightly convex and converging, posterior margin excavated on both sides of an unnotched median lobe extending slightly further posteriorly than lateroposterior corner.

Types: Holotype male, allotype female and 2 female paratypes, Suwanee Springs, Florida, July 29, 1930, R. H. Beamer. Additional paratypes from Florida as follows: 1 female, Wakulla Springs, July 14, 1934, R. H. Beamer; 1 female, Suwanee Springs, July 29, 1930, 1 male, Old Town, July 11, 1939, P. W. Oman. Types and paratypes in the Kansas University collection.

This species is closely related to *flavus*, from which it may be sep-

arated by its slightly larger size, markings on vertex and frons usually present and the longer, more slender forks of the pygofer hook.

22. *Eutettix bartschi* Van Duzee

Eutettix bartschi, Van Duzee, Bull. Buff. Soc. Nat. Sci., ix, 223, 1909.

Resembling *luridus*, but smaller, with frons of female unmarked except for basal band, with long processes at apex of aedeagus and with pygofer hook small and single. Length: Male, 4.2 mm.; female, 5 mm.

Vertex about twice as wide as length at middle, almost parallel-margined, transverse furrow distinct; tegmen semihyaline with some light and clouded areas.

Color: Frons of male dark fuscous, almost black, with about six diagonal arcs on each side, yellow; female, yellow with only base fulvous to fuscous and arcs sometimes faintly indicated; vertex and scutellum ivory to yellow with typical markings fulvous, usually darker in the male; pronotum darker than vertex, lightest along anterior margin. Tegmen semihyaline fulvous, darkest in male, veins distinct only in light areas, commissural spot distinct.

Male genitalia: Pygofer long-ovate, about three-fourths as wide at constriction as length from there to apex; pygofer hook short, slightly longer than one-half width of pygofer at constriction, sinuately narrowed to a sharp point. Aedeagus in lateral view about five times as long as basal width, almost parallel-margined throughout its length, a pair of erect, apical processes about one-half length of shaft of aedeagus.

Female genitalia: Last ventral segment about twice as wide as length at middle, almost straight along anterior margin, lateral margins slightly convex, posterior margin straight, except for distinct unnotched median lobe.

Types: Lectotype male, allotype female, in the Ohio State University collection, Columbus, Ohio.

Material studied: (Florida) Fort Myers, Homestead, Orange Co., St. Petersburg, Sanford, St. Augustine, Hudson, La Belle, Hobe Sound, Likely, Cocoanut Grove, Tampa, Sebring, Elfers, Old Town and West Palm Beach.

The female of this species can be separated easily from any other species in the genus by the peculiar coloration of the frons. However, occasionally a specimen will be found in which the band extends over most of the frons.

23. *Eutettix minutus* n. sp.

Resembling *bartschi*, but smaller in size, with slightly longer vertex, with frons yellow and with typical markings only faintly indicated. Length: Male, 4 mm.; female, 5 mm.

Vertex slightly less than twice as wide as length at middle, bluntly pointed, transverse furrow distinct; tegmen semihyaline with small clouded areas sometimes present in the clavus.

Color: Frons ivory-yellow with markings faintly indicated in the male and absent in the female; vertex and scutellum ivory-yellow to light fulvous with typical markings distinct and slightly darker; pronotum fulvous to brownish-grey, lightest along anterior margin, much darker in the male than in the female. Tegmen semihyaline fulvous with veins darkening posteriorly, four spots along claval margin, and extreme apex, fuscous, commissural spot usually only lightly indicated.

Male genitalia: Pygofer ovate, about three-fourths as wide at constriction as length from there to rounded apex; pygofer hook reaching almost to apex of pygofer, broadest on outer third, notched on outer fifth, apex pointed. Aedeagus in lateral view almost five times as long as basal width, broadest near middle, a pair of apical processes broadest near apex, slightly less than one-half length of shaft of aedeagus.

Female genitalia: Last ventral segment about twice as wide as length at middle, almost straight along anterior margin, lateral margins convex and converging, posterior margin almost straight except for distinct notched median lobe.

Types: Holotype male, allotype female and 11 male and 1 female paratypes, Shamrock, Tex., Aug. 10, 1941, R. H. Beamer. Additional paratypes as follows: 3 male, Shamrock, Tex., Aug. 10, 1941, E. L. Todd; 1 female, Sutton Co., Tex., July 16, 1928; 1 male, Wichita National Forest, Okla., June 28, 1936, R. H. Beamer; 1 male, Concan, Tex., June 4, 1933, P. W. Oman. Types in the Kansas University collection and paratypes in this collection and the National Museum.

This species resembles *fulvous*, but may be separated by its slightly more pointed vertex, more slender processes at apex of aedeagus, notch near apex of pygofer hook and distribution.

24. *Eutettix fulvous* n. sp.

Resembles *southwicki*, but smaller, with a sharper vertex, tegmen darker and with the markings on vertex darker. Length: Male, 4.2 mm.; female, 5 mm.

Vertex about twice as wide as length at middle, obtusely pointed; transverse furrow distinct; tegmen semihyaline but usually with irregular clouded areas.

Color: Frons, vertex, pronotum and scutellum ivory-yellow to fulvous with typical markings usually distinct and slightly darker; tegmen fulvous semihyaline with fuscous clouded areas in discal cell, at end of claval veins and in apical cells; veins darkening posteriorly.

Male genitalia: Pygofer ovate, about three-fourths as wide at constriction as length from there to apex; pygofer hook reaching almost to apex of pygofer, gradually broadening to outer fifth, then narrowing suddenly to a sharp point. Aedeagus about five times as long as basal width, almost parallel-margined throughout its length, a pair of apical processes widest on outer third and slightly longer than one-half length of shaft of aedeagus.

Female genitalia: Last ventral segment slightly less than twice as wide as length at middle, almost straight along anterior margin, lateral margins slightly convex, posterior margin straight, except for notched median lobe.

Types: Holotype male, allotype female and one pair of paratypes, Lacoochee, Fla., Aug. 18, 1930, R. H. Beamer. Additional paratypes from Florida as follows: 1 male, Yankeetown, July 31, 1930; 1 male, Sanford, July 22, 1939, P. W. Oman; 1 male, Hudson, July 13, 1939, R. H. Beamer; 3 pairs, Sanford, Nov. 3, 1925, 1 male, Sept. 10, 1925, 3 male, June 2, 1926, 1 male, Sept. 2, 1926, 2 male, Oct. 24, 1926, 2 male, 5 female, June 18, 1926, 1 female, Feb. 14, 1926, 1 female, Sept. 7, 1925, 2 female, June 22, 1926, 2 female, July 3, 1926, 2 female, Sept. 9, 1925, 1 female, Sept. 4, 1926, E. D. Ball. Types in the Kansas University collection and paratypes in this collection, the E. D. Ball collection and National Museum.

25. *Eutettix hibernus* n. sp.

Similar to *nitens*, but with pronotum about same color as tegmen and with markings on vertex and frons distinct. Length: Male, 5 mm.; female, 6½ mm.

Vertex slightly over twice as wide as length at middle, almost parallel-margined, transverse furrow distinct; tegmen varying from translucent in clavus to semihyaline along costal margin.

Color: Frons of male fulvous with typical markings ivory-white, frons of female ivory-yellow with markings fuscous except for chocolate-brown band covering basal third; vertex and scuttellum ivory-white to fulvous with typical markings at least faintly indicated;

pronotum reddish-brown, darkest in male, with four pairs of dots along anterior margin distinct. Clavus and adjacent area of corium translucent to opaque dark brown to reddish-brown, outer half of corium light fulvous semihyaline.

Male genitalia: Pygofer about two-thirds as wide at constriction as length from there to apex; pygofer hook bifid, dorsal fork curved abruptly near base, slightly broadest on outer third, apex pointed, ventral fork much narrowest on basal two-fifths, broadest near middle, apex pointed. Aedeagus in lateral view about four times as long as greatest width, almost parallel-margined on basal three-fifths, narrowing to a rounded apex, a pair of short processes on dorsal margin near apex; in ventral view, bifid on outer two-fifths.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior margin almost straight, lateral margins slightly convex and converging posteriorly, posterior margin almost straight except for unnotched median lobe.

Types: Holotype male, allotype female and 1 male paratype, Grisdon, Florida, Feb. 4, 1941, L. W. Hepner. Paratypes: 1 male, Seminole Co., Fla., Jan. 10, 1930, 1 male, Jan. 3, 1930, W. M. Loe; 1 male, St. John Co., Fla., Feb. 28, 1930, L. L. Knight; 1 female, Columbia Co., Fla., Jan. 27, 1930, R. B. Howard. Types in the Kansas University collection and paratypes in this collection and the National Museum.

At first it seemed that this might be a winter form of *nitens,* but typically colored *nitens* specimens have also been collected in the winter.

26. *Eutettix borealis* n. sp.

Resembles *nitens*, but larger, pronotum about same color as tegmen, markings on frons distinct and found in northeast United States. Length: Male, 6½ mm.; female, 7 mm.

Vertex almost two and one-half times as wide as length at middle, almost parallel-margined, transverse furrow distinct; tegmen varying from transluscent in clavus to semihyaline in costal cell.

Color: Frons fulvous with markings lighter, some dark markings in the male; vertex fulvous with typical markings brown to reddish-brown; pronotum brownish-yellow to reddish-brown, light markings along anterior margin distinct; scutellum fulvous with typical markings darker; tegmen reddish in the female, brownish-yellow in the male, varying from translucent in the clavus to semihyaline fulvous in the costal cell.

Male genitalia: Pygofer about two-thirds as wide at constriction

as length from there to pointed apex; pygofer hook bifid, dorsal fork slender, almost parallel-margined, curved abruptly near base, ventral fork much narrowed on basal two-fifths, broadest near middle, apex pointed. Aedeagus in lateral view about four times as long as greatest width, almost parallel-margined on basal half, then narrowing to a rounded apex, a pair of short processes on dorsal margin near apex.

Female genitalia: Last ventral segment about twice as wide as length at middle, posterior and lateral margins almost straight, lateral margins slightly converging posteriorly, posterior margins somewhat convex with a prominent unnotched median lobe.

Types: Holotype male, Durham, N. H., Sept. 21, 1922; allotype female, Woods Hole, Mass., July 4, 1925, E. D. Ball. 1 female paratype, Woods Hole, Mass., July 7, 1925, E. D. Ball. Types and paratypes in the E. D. Ball collection.

The genitalia of this species resemble those of *nitens*, but *borealis* is found in the northeastern part of the country and differs in being reddish-brown in color.

27. *Eutettix luridus* (Van Duzee)

Thamnotettix luridus, Van Duzee, Can. Ent. xxii, p. 250, 1890.

Resembles *subaeneus*, but shorter, with a shorter vertex and without two pairs of apical processes on the aedeagus. Length: Male, 5½ mm.; female, 6 mm.

Vertex slightly more than twice as wide as length at middle, almost parallel-margined, transverse furrow shallow; tegmen varying from translucent on the clavus to semihyaline on the corium.

Color: Frons fulvous with typical markings lighter, vertex and scutellum ivory-yellow with typical markings fulvous to deep reddish-brown, pronotum fulvous to reddish-brown with typical markings usually distinct. Tegmen translucent with clavus and adjacent area of corium deep fulvous to bright reddish-brown except for large white spot near apex; corium fulvous semihyaline with veins darker, apical cells sometimes slightly clouded.

Male genitalia: Pygofer long, about two-thirds as wide at constriction as length from there to pointed apex; pygofer hook bifid, dorsal fork shorter than ventral, gradually narrowing to sharp apex, ventral fork slightly broader than dorsal, almost parallel-margined to a sharp apex. Aedeagus in lateral view slightly over four times as long as greatest width, largest near middle, narrowing to a rounded apex on apical third; in ventral view bifid on outer third.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior margin almost straight, lateral margins slightly convex, posterior margin slightly convex except for large unnotched median lobe.

Types: Lectotype male, Ames, Iowa, May 19, 1881, allotype female Agricultural College, Michigan, October 24, 1888 in the Iowa State collection.

Material studied: Material is on hand from many points in the eastern half of the United States. The species is replaced west of Kansas by *discolor*.

28. *Eutettix discolor* n. sp.

Resembles *luridus*, but with transverse furrow more distinct, duller colored and with the dorsal fork of the pygofer hook curved abruptly near base. Length: Male, 5½ mm.; female, 6 mm.

Vertex two to two and one-half times as wide as length at middle, almost parallel-margined in female, slightly pointed in male, transverse furrow distinct; tegmen semihyaline with clouded spots in clavus, discal cell and apical cells.

Color: Frons fulvous with typical markings darker, vertex and scutellum ivory-white with markings fulvous and distinct, pronotum darker with typical markings usually evident; tegmen light semihyaline fulvous, darker along margin of clavus, except for white spot near apex of clavus, brown spot in discal and middle anteapical cells, apical cells sometimes slightly infuscated.

Male genitalia: Pygofer long, about two-thirds as wide at constriction as length from there to pointed apex; pygofer hook bifid, dorsal fork shortest, curved sharply near base, almost parallel-margined to sharp apex, ventral fork widest on outer half, apex pointed. Aedeagus in lateral view about seven times as long as greatest width, almost parallel-margined to outer third, narrowed to a rounded apex, a pair of short spines on dorsal margin at apical fourth.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior and lateral margins almost straight, posterior margin slightly excavated on each side of a slightly notched median lobe.

Types: Holotype male, allotype female, and 17 pairs of paratypes, Ruidosa, N. Mex., Oct. 10, 1940, John Medler. Additional paratypes as follows: 5 male, 2 female, Coffeyville, Kansas, Oct. 15, 1939, L. W. Hepner; 2 pairs, Douglas county, Kansas, Oct. 15, 1936, R. H. Beamer; 1 male, Cherokee County, Kansas, July 19,

1941, R. H. Beamer; 1 male, Anderson County, Kansas, Oct. 24, 1929, P. W. Oman; 1 male, Galena, Kansas, Oct., 1912; 1 male, 3 female, Riley County, Kansas, Oct., Marlatt; 1 male, 2 female, Chisos Mts., Tex., Sept. 19, 1938, D. J. & J. N. Knull; 6 male, 5 female, Douglas County, Kansas, Oct. 8, 1938; 1 pair, Ruidosa, N. Mex., June 26, 1940, R. H. Beamer. Types in the Kansas University collection; paratypes in this collection and the National Museum.

This species replaces *luridus* in the western part of the country, but differing in color and in the genital characters.

29. *Eutettix southwicki* Van Duzee

Eutettix southwicki, Van Duzee, Bull. Buff. Soc. Nat. Sci., v, 209, 1894.

Resembles *marmoratus* but with apical processes of aedeagus much longer; pygofer hook smaller. Length: Male, 5 mm.; female, 6 mm.

Vertex almost two and one-half times as wide as length at middle, almost parallel-margined, transverse furrow shallow, especially in the male; tegmen semihyaline fulvous, darkest in the male, with apical cells slightly infuscated.

Color: Face fulvous with markings, if present, darker; vertex, pronotum and scutellum fulvous to dark gray, darkest in the female, with markings distinct. Tegmen of male semihyaline fulvous throughout; veins of female darkening posteriorly with a few fuscous spots in clavus and adjacent area of corium with apical cells infuscated.

Male genitalia: Pygofer oval, about two-thirds as wide at constriction as length from there to truncate apex; pygofer hook single, almost parallel-margined on outer three-fourths, extending almost to apex of pygofer. Aedeagus in lateral view about four times as wide as greatest width, almost parallel-margined throughout, a pair of broad apical processes about twice as long as greatest width, over one-half as long as shaft of aedeagus.

Female genitalia: Last ventral segment about twice as wide as length at middle, slightly convex on lateral margins. Posterior margins slightly excavated on each side of a distinctly notched median lobe.

Types: Lectotype male, New York City, Aug. 12, 1891, E. B. Southwick in the Iowa State College collection, Ames, Iowa; allotype female, New Haven, Conn., Aug. 23, 1934, C. O. Dunbar, here designated, in the Kansas University collection.

Ball (Proc. Dav. Acad. Sci., xii, 36, 1907) stated that *E. brunneus* is a synonym of this species, but examination of the types showed that these two are distinctly different. Series of this species are rare and the females are much like *marmoratus*.

30. *Eutettix marmoratus* Van Duzee

Eutettix marmoratus, Van Duzee, Trans. Am. Ent. Soc., xix, 302, 1892.
Eutettix brunneus, Osborn, in 20th Rep. St. Ent. N. Y., 530.

Resembles *tristis*, but with markings on pronotum and frons absent, with aedeagus not bifid and with apical processes on aedeagus. Length: Male, 5 mm.; female, 6 mm.

Vertex almost three times as wide as length at middle, almost parallel-margined, transverse furrow distinct; tegmen semihyaline.

Color: Frons fulvous with typical markings slightly darker, vertex and scutellum ivory-yellow to fulvous with typical markings darker, scutellum fulvous to gray, lightest along the anterior margin; tegmen semihyaline fulvous with clouded areas across tegmen on anterior third and on apical cells. In some of the specimens, all color markings are absent and the specimens are fulvous throughout.

Male genitalia: Pygofer ovate, about three-fourths as wide at constriction as length from there to apex; pygofer hook extending almost to apex of pygofer, broadest on outer third. Aedeagus in lateral view about five times as long as greatest width, almost parallel-margined, a pair of slender apical processes about one-third length of shaft.

Female genitalia: Last ventral segment about twice as wide as length at middle, anterior and lateral margins almost straight, posterior margin slightly excavated on both sides of the unnotched median lobe.

Types: Holotype female, Balsam, N. C., July 23, 1890, W. J. Palmer in the Iowa State collection. *E. brunneus* types in the Ohio State collection.

This species is either quite variable or else there are several closely related subspecies. Collected material is rather scanty in the group with series small. The aedeagus may be much longer and more slender than typical and the pygofer hook may vary from slender to twice as wide as that of the type.

Plate XXII

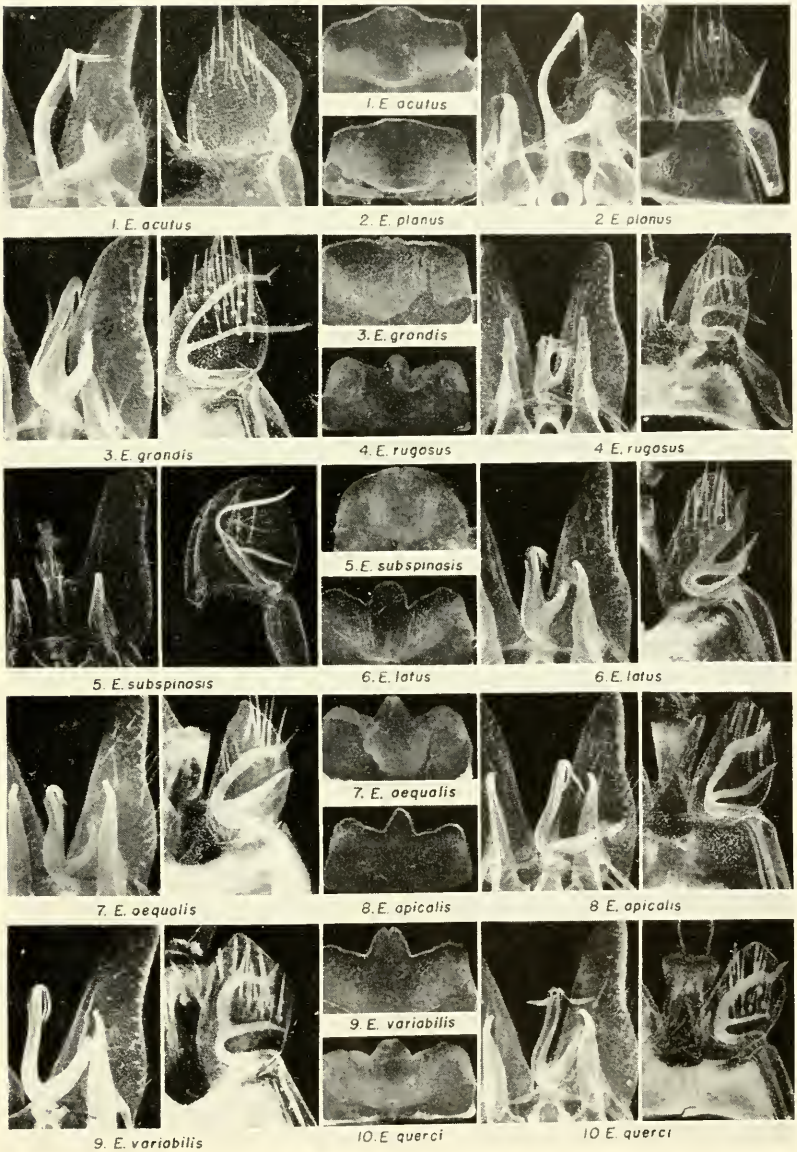

1. E. acutus
1. E. acutus
2. E. planus
2. E. planus
3. E. grandis
3. E. grandis
4. E. rugosus
4. E. rugosus
5. E. subspinosis
5. E. subspinosis
6. E. latus
6. E. latus
7. E. aequalis
7. E. aequalis
8. E. apicalis
8. E. apicalis
9. E. variabilis
9. E. variabilis
10. E. querci
10. E. querci

Plate XXIII

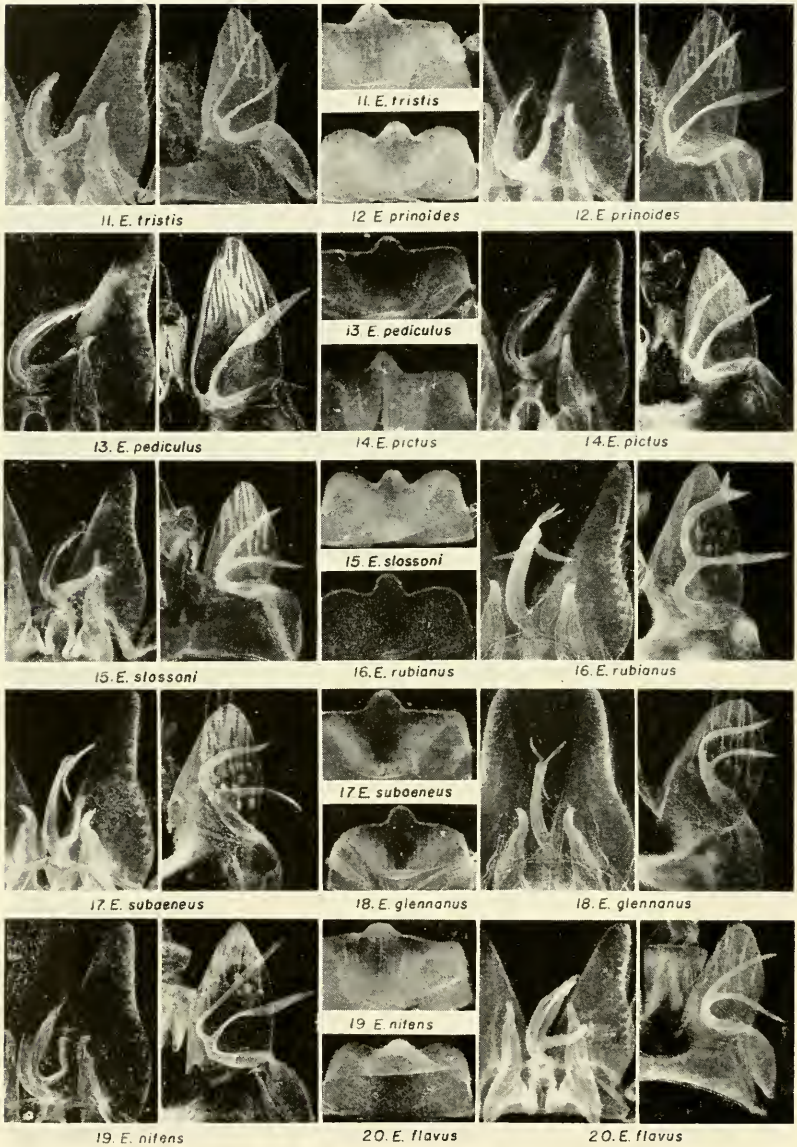
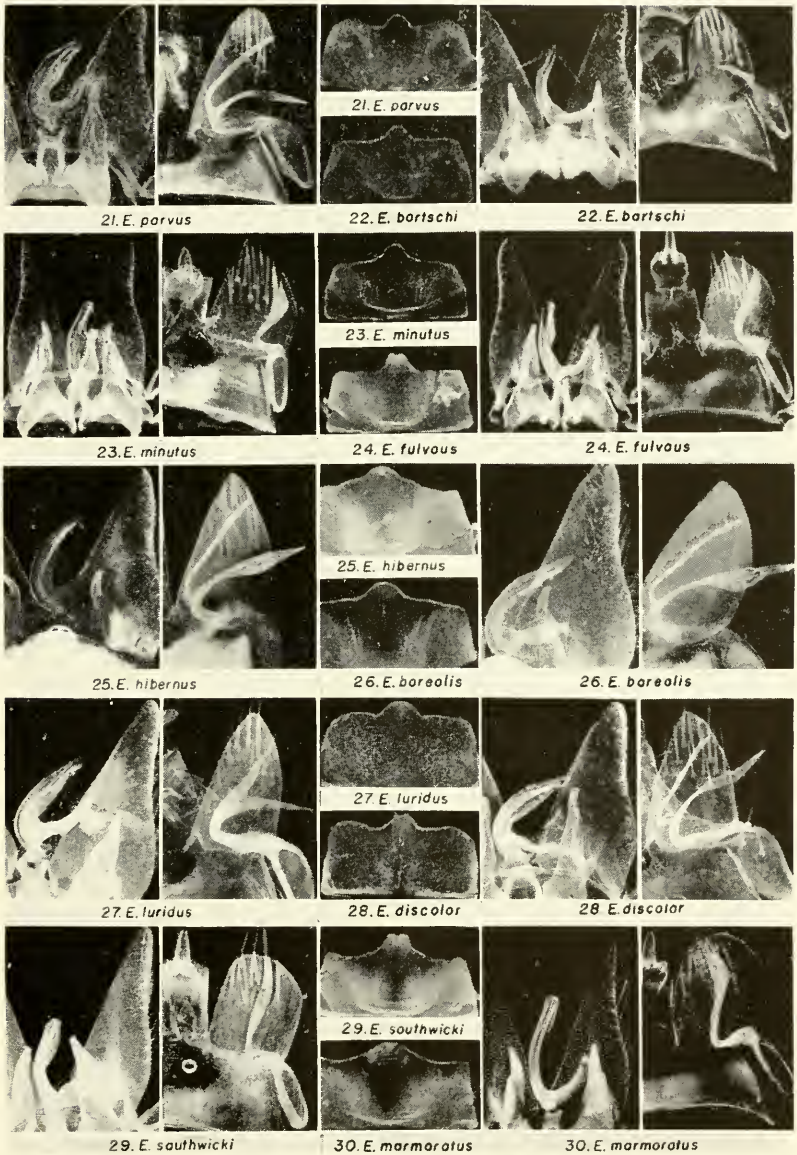

11. E. tristis
12 E prinoides
12. E prinoides
11. E. tristis
13 E. pediculus
13. E. pediculus
14. E. pictus
14. E. pictus
15 E. slossoni
15. E. slossoni
16. E. rubianus
16. E. rubianus
17 E. suboeneus
17. E. suboeneus
18. E. glennanus
18. E. glennanus
19 E. nitens
19. E. nitens
20. E. flavus
20. E. flavus

Plate XXIV


21. E. parvus
22. E. bortschi
22. E. bortschi
23. E. minutus
24. E. fulvous
24. E. fulvous
25. E. hibernus
26. E. boreolis
26. E. boreolis
27. E. luridus
28. E. discolor
28. E. discolor
29. E. southwicki
30. E. marmoratus
30. E. marmoratus

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New Caudata and Salientia from Mexico

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ABSTRACT: A series of new Salientia is described from México, as follows: *Bolitoglossa lavae*, from near La Joya, Veracruz (Caudata, Plethodontidae); *Eleutherodactylus hidalgoensis*, north of Tianguistengo, Hidalgo, *Eleutherodactylus decoratus*, six miles west of Jalapa, Veracruz, *Eleutherodactylus bolivari*, Ixtapan del Oro, México, *Syrrhophus modestus*, Hacienda Paso del Río, Colima (Salientia, Leptodactilidae); *Hyla pachyderma*, Pan de Olla, Veracruz, *Hyla beltrani*, Tapachula, Chiapas (Salientia, Hylidae); *Rana megapoda*, near Chapala, Jalisco (Salientia, Ranidae). Most of the species are figured.

Bolitoglossa lavae

(Plate XXVII, figs. 5-6)

Type.—EHT-HMS No. 28937 ♀; collected 2 miles west of La Joya, Veracruz, August 16, 1941, by Edward H. Taylor.

Paratypes.—EHT-HMS Nos. 28930-28936; 28938-29064. Topotypes collected at same time and place by Dyfrig Forbes, Gabino Garcia, and Edward H. Taylor.

Diagnosis.—A small bromeliad salamander belonging to the *chiroptera* group; tip of toes rounded, the toes touching or slightly overlapping when limbs are adpressed; 11 costal grooves, the inguinal and axillary apparently wanting; 25-26 Maxillary-premaxillary teeth on each side of jaw; vomerine teeth about 6 on each side curving strongly backwards, separated medially by a distance equal to more than distance between two teeth, and from parasphenoid teeth by a distance three times as great; parasphenoid teeth in double series separated medially by a narrow interval. In males maxillary-premaxillary teeth reduced to from three to five on each side, those of the premaxilla piercing the lip.

Description of the type.—A small species, the known maximum snout to vent measurement, 35 mm.

Head broader than body; width of head (6 mm.) contained in the distance between tip of snout and anterior end of vent (33 mm.) 5.5 times; distance between orbits, (2 mm.), much wider than an eyelid (1.3 mm.); nostril small, a slight swelling of the subnarial region on upper lip; a minute fold back of the corner of eyelid (in some specimens, when the eye is not open widely the posterior corners of the eyelid are tucked under this fold); dorsal surface of head and snout flat, strongly and uniformly pitted; snout narrowed, nearly truncate anteriorly, lacking a canthus rostralis; nuchal fold on throat curving back slightly on side of neck, then curving forward to meet its fellow on the middorsal line; a vertical groove just back of the jaw angle reaches the dorsal surface of neck; an indistinct groove connects the two vertical grooves; no groove running back from behind eye.

Eleven distinct costal grooves, the axillary groove and one in the inguinal region missing; tail not or but slightly constricted posterior to the anus; tail not especially fragile as none of the type series has the tail broken; about 36 indistinct caudal grooves behind anus; tail very slightly compressed laterally; body a little broader than high; adpressed limbs overlap the length of one costal fold; fold formed by the posterior extension of hyoid terminates at the second costal fold. A small gland behind the insertion of hind leg. Skin smooth, not puckered on sides; pits over most of body much smaller than those on head; anal opening (of female) with diagonal folds (of male, with papillae).

Limbs large, well developed, the hand and foot spread wide; digits very wide, rounded at tip, minutely narrowed some distance back from tip. The web involves the first finger completely, the proximal phalanges of each of the other fingers and part of the second; foot with the web involving first toe, the proximal phalanges and proximal parts of the second series of the other toes.

Tongue boletoid, free; a semicircular, sublingual fold; maxillary-premaxillary teeth 28 on each side (allowing for missing teeth); about the same number of mandibular teeth; vomerine teeth 6-6, lying almost wholly between the inner level of choanae, curving back strongly, the two series separated by a distance a little greater than that between two teeth; separated from the parasphenoid teeth by a distance three times as great; parasphenoid teeth in two elongate series, which are widened posteriorly; palatal membranes with considerable pigment about the posterior part of the parasphenoid teeth; posterior to the maxillary-premaxillary teeth, the gums are strongly papillate; choanae moderately large.

Color.—Above dull brownish with indistinct spotting of darker color, somewhat more concentrated in the dorsolateral region; low on the sides of head and body, and the entire ventral surface, dirty whitish (actually evenly pigmented black on creamy background); a trace of two short cream diagonal lines on dorsal surface at base of the tail.

Measurements in mm.—Snout to vent, 33; snout to arm, 10.2; axilla to groin, 18; tail, 42; arm, 10.2; leg, 10.2.

Variation.—In the very large series of paratypes there is a considerable variety in color pattern.

1. A series of about 20 have the ventral surfaces dark, the tails being usually equally dark above and below. The color above on back is dark brown or blackish, or there may be a median cream line, a pair of dorsolateral lines, of pinkish or cream, distinctly separated from the blackish lateral coloration. In practically all there is some variegation of the dorsal surface. There also may be a lighter spot on shoulders and a pair of short, light lines at the base of the tail. All of the dark specimens are young, to nearly grown, females.

2. All the remainder of both sexes are nearly equally light on the ventral surfaces but vary much in dorsal color and markings. Eight of these have the head variegated brown, the dorsolateral region dark and the back and dorsal surface of the tail nearly uniform cream. A similar number of specimens have two narrow dorsolateral lines, the back and tail, light, with numerous fine spots or reticulations. A few specimens appear nearly uniform lavender above, the sides lacking the dark areas. The larger part of the remainder are marked much as is the type. In almost all, however, there is a light nuchal spot and two short, lighter lines at base of the tail (often forming a V-shaped mark) are present.

There is little variation in the number of teeth in the adult females. Very young males resemble females in the number of maxillary teeth but in old males only three or four are present, these much enlarged. There is a slight difference in the relative lengths of the limbs, to the axilla-to-groin length, in adult males, and the overlap of the adpressed limbs is a little greater than in the type.

Remarks.—This variety of color pattern is present in most of the forms of the *chiroptera* group. It is certainly present in *xolocalcae, terrestris* and *multidentata;* to a lesser extent this variation occurs also in *chiroptera, chondrostega,* and *arborea.* Whether this condition obtains in *mosaueri* I do not know.

This species may be separated from the above species by the character of the teeth and the relatively large limbs and feet. This character seems to be associated with its arboreal habitat. All the specimens were taken from bromelias growing in the stunted forest of the lava fields west of La Joya, Veracruz.

Eleutherodactylus bolivari sp. nov.

(Pl. XXVI, figs. 1 to 4)

Type.—EHT-HMS No. 29564 ♂ ; collected at Ixtapan del Oro México, México, by Dr. C. Bolivar Pieltain, June 11, 1941.

Diagnosis.—A member of the augusti group, probably most closely related to *Eleutherodactylus tarahumaraensis* Taylor, but differing from this and other members of the group in lacking a vocal sac.

Description of the type.—A small species of the *agusti* group, the snout to vent measurement 44 mm. Body and limbs slender lacking all trace of an interdigital membrane; head a little wider than body; width of eyelid (4.2 mm.) minutely greater than interorbital distance (4.1 mm.); length of eye (5.7 mm.) greater than interval between eye and nostril (5.1 mm.); length of snout (7 mm.), greater than eye length; width of tympanum (2.6 mm.), less than its height (3.3 mm.), its greatest diameter almost half greatest diameter of eye; elevation of head immediately in front of eye equals distance between eye and nostril; canthus rostralis rounded; loreal region sloping obliquely to lip, not or very slightly concave.

Tongue longer than wide, slightly nicked behind, free for one-fourth of its length behind, and for nearly a third of its width laterally save near tip; vomerine teeth in two slightly diagonal, elevated groups which lie between, but fail to reach forward to the posterior level of the choanae; the groups closely approximated, but separated from choanae by an interval equal to more than twice the width of one group; palatal glands open medially, near the anterior level of choanae, by ten longitudinal slits.

Arms slender, rather long; first finger longer than second; tips of digits very slightly wider than the digits, the tips bulbous or swollen, lacking any trace of a transverse groove at tip; subarticular tubercles large, elevated, rounded, not pointed at top; six supernumerary tubercles; median palmar tubercle, large, elongate, elevated, lying close to, and partially joined to the posterior part of the smaller, outer tubercle; inner tubercle intermediate in size, strongly elevated anteriorly; under side of arm smooth, without pustules.

Legs slender, rather short, the tibiotarsal articulation reaching anterior corner of eye or slightly beyond; tips of toes similar to those

of fingers; subarticular tubercles smaller than those on fingers; eight supernumerary tubercles on sole and traces of intercalary tubercles; outer metatarsal tubercle more than half the area of the large inner tubercle but less elevated; no trace of a tarsal fold or outer tarsal tubercles; length of inner metatarsal tubercle more than half the interval between tubercle and tip of toe.

Skin very smooth, but with numerous, flat, smooth-surfaced tubercles visible on back and femur; an indistinct skinfold across occiput; sides somewhat more strongly tuberculate; chin, breast, and most of the venter, smooth, the lateral granulation encroaching on the latero-posterior edges of the ventral disk; no inguinal or axillary glands; ventral and posterior faces of femur with strong granulation on proximal parts and indistinct granular patches on each side of the groove, posterior to anal opening.

Color.—The ground color is light, bluish-gray with numerous blackish spots, varying in size; upper lip spotted; venter clouded with brown; limbs strongly barred with alternating broad and narrow, dark brown bands, separated by cream bands.

Measurements in mm.—Snout to vent, 44; width of head, 18; length of head, 17.5; arm, 31; leg, 64; tibia, 21.5; foot, 28.

Remarks.—The absence of the vocal sac clearly differentiates this species from the presumed related Mexican forms, *Eleutherodactylus agusti, cactorum, latrans,* and *tarahumaraensis. E. laticeps* differs in having a small web between the toes, and a sharp-edged tarsal fold.

This species is named for its discoverer, Prof. C. Bolivar Pieltain, a noted Spanish scientist.

Eleutherodactylus hidalgoensis sp. nov.

(Plate XXV, figs. 5 to 8; Plate XXVII, fig. 10)

Type.—EHT-HMS No. 24454 ♂ ; collected about 4 miles north of Tianguistengo, Hidalgo, July 3, 1940, by Edward H. Taylor.

Paratype.—EHT-HMS No. 24455 collected with the type.

Diagnosis.—Belonging in the *alfredi* group of the genus. Tibiotarsal articulation reaches a little beyond tip of snout; tympanum less than one half the diameter of the eye. Digits dilated similar to those of *spatulatus,* but not so distinctly emarginate; vocal sac present; canthus rostralis rounded.

Description of type.—A small frog, the head as wide as body, somewhat constricted back of the head. Eyelid (3 mm.) equal to the interorbital distance (3 mm.); length of eye (4 mm.) greater

than interval between the eye and nostril (3.2 mm.); tympanum a little higher than wide, its greatest diameter (1.75 mm.) less than half the length of the eye; length of snout, 4.6 mm.

Tongue subcircular notched behind, free for one third of its length behind and widely free on the sides; openings of the vocal sacs distinct; vomerine tooth groups diagonal, elongated, lying behind the posterior level of the choanae, but between the level of their inner margins; groups are separated from the choanae by a distance more than twice as great as that which separates the two groups. The several openings of the palatal gland lie between the anterior part of the choanae; choanae much larger than area of one vomerine tooth group.

Arm moderate, the digits with much widened terminal disks, especially on outer fingers, the two outer disks with slight, medial, terminal emarginations (seen from above); first finger, with very small disk, much shorter than second finger; subarticular tubercles large, rounded; six supernumerary tubercles, some nearly as large as the subarticular tubercles; the median palmar tubercle elongate, curved, separated from the outer tubercle by a curved line; inner palmar tubercle intermediate in size but more rounded and nearly same area as middle; a row of tubercles under the forearm.

Leg moderately long, the tibiotarsal articulation reaching very slightly beyond the tip of the snout; large inner metatarsal tubercle more than twice the size of the outer, its length a little less than half the interval between the tubercle and tip of first toe; disks on toes much smaller than those of fingers; third and fifth toes reach forward to the same point; toes rather flattened with sharp lateral edges, and a trace of an interdigital membrane; toe disks with slight emargination on middle toes, all disks with transverse terminal grooves; only a faint trace of inner tarsal fold (one or two indistinct tubercles), and several irregular outer tarsal tubercles; three or four very small, indistinct, supernumerary tubercles on sole.

Skin above very rugose, with small tubercles and pustules; an indistinct, occipital fold; a semicircular fold above tympanum; no dorsal skinfolds; sides pustular or granular; these encroach on the well-defined ventral disk; chin with ample skinfolds of the vocal sac; breast wrinkled or slightly corrugated. Inguinal gland present but indistinct; no distinct axillary gland; dorsal surface of femur, tibia, and arm pustular; more medial parts of ventral and posterior faces of femur with pavement-like granules; several tubercles below and behind tympanum; apparently no paratoid gland; when legs

are folded at right angles to the body, the heels overlap one-half to one millimeter.

Color in life.—Yellowish cream above with indistinct darker markings on head, dorsum and sides; an indistinct W-shaped dark pattern back of occiput; legs barred with grayish, the lines continuous across femur, tibia, and foot when limb is folded; ventral surfaces bright greenish-yellow with a minute peppering of blackish pigment; underside of hand and foot yellowish.

Measurements of type and paratype in mm.—Snout to vent, 28.5, 22; width of head, 11.5, 8.9; length of head, 11.8, 9.4; arm, 20.2, 15; leg, 49.5, 41; tibia, 16, 14; foot, 20.5, 18.

Variation.—The single paratype is smaller but otherwise resembles the type in most characters. Both are males.

Remarks.—The specimens were obtained at night from trees by tracing their calls. The call is difficult to describe, but when first heard at some distance it resembled the querulous notes of *Rana pipiens;* and until I discovered that the sound came from trees I was certain I was trailing a *Rana.* Many individuals were heard, but the difficulty involved in ascending trees with a lantern during a shower, and then locating the frog, mitigated against acquiring a series.

The key given under *Eleutherodactylus decoratus* shows the differential characters of the members of the *alfredi* group of the genus.

Eleutherodactylus decoratus sp. nov.

(Plate XXV, figs. 1-4; plate XXVII, fig. 9)

Type.—EHT-HMS No. 28720 ♀; collected near Banderia, 6 miles west of Jalapa, Veracruz, Aug. 16, 1941 by Edward H. Taylor.

Paratype.—EHT-HMS No. 28719; collected two miles west of La Joya, Veracruz, Aug. 15, 1941, by Edward H. Taylor.

Diagnosis.—A small Eleutherodactylid of the *alfredi* group related to *E. spatulatus* (see Plate XXVII, figs. 7, 8 and 11), but differing in having a longer leg, the tibiotarsal articulation reaching considerably beyond the snout; canthus rostralis distinct, moderately sharp; tips of digits all more or less emarginate at tip (seen from above), but a little smaller than in *spatulatus* or other related forms.

Description of the type.—A small species, the known maximum size 25 mm.; width of eyelid (2.2 mm.) less than interorbital distance (3.3 mm.); diameter of the tympanum (1.25 mm.) less than half the diameter of the eye (3 mm.); diameter of eye equals interval between eye and nostril; length of snout 4.65 mm.; canthus

rostralis moderately distinct, the lines of which, if projected, intersect about half way between nostrils and tip of snout; areas about nostrils distinctly elevated, moundlike, with a broad depression between; snout pointed; loreal region broadly sloping to lip, not, or but slightly concave; the skin of the loreal region pustular and corrugated, with a few tiny tubercles below eyes; top of head very smooth; lying between the orbits and on occiput is a circumscribed, elevated, median area having somewhat the appearance of a blunt arrow, directed backwards. The entire elevation is bordered by a minute ridge.

Tongue slightly longer than broad, notched behind; free behind for more than one-third of its length, and broadly free on sides save at tip; vomerine tooth groups diagonally placed, lying behind choanae, but well within the level of the inner margins of choanae, separated from them by a distance greater than the length of one group, and from each other by less than half this distance; palatal glands open in a short, medial, transverse groove, which lies at the anterior level of choanae; choanae small, about the area of a group of vomerine teeth.

Arm rather short; fingers with widened, flattened disks, notched at the tip (seen from above), each with a distinct transverse groove at tip; no trace of interdigital membranes; subarticular tubercles large, rounded; seven supernumerary tubercles; median palmar tubercle much larger than the outer and separated from it only by a groove; inner tubercle of intermediate size.

Legs long and slender, the tibiotarsal articulation reaching beyond the snout, a distance equal to interval between eye and nostril; third and fifth toes reach forward to the same point on the fourth toe; toes rather flattened with sharp lateral edges and traces of interdigital membranes; disks of toes are distinctly smaller than finger disks; inner metatarsal tubercle compressed, strongly salient; outer tubercle more than half as large; a few supernumerary tubercles.

A very indistinct broken ridge begins behind posterior corner of eye, runs diagonally backward some distance then continues parallel to body dorsolaterally; area on back between these lines, smooth anteriorly but pustular and granular posteriorly; sides more or less tubercular or pustular; chin and breast smooth; ventral disk moderately distinct, the posterior part of which is roughened by small granules or corrugations; more medial parts of femur on ventral and posterior surfaces granular; upper surface of femur with some pustules; a trace of tarsal fold indicated by an elongate tubercle; a

slight fold above tympanum. Inguinal gland present but indistinct, its extent on the surface is discernible by the pitted nature of the skin; an indistinct paratoid gland above arm.

Color in life.—The head dark above; back bright red (faun color in preservative) between the dorsolateral ridges; sides darker, indefinitely streaked or mottled with black; lip spotted dark and light, with a larger dark spot below eye; a dark spot in supratympanic region; legs barred with brown with lighter intervals between; under surfaces of hands and feet dark; venter mottled and clouded, with dark; under surface of femur and tibia speckled brown.

Measurements in mm. of type and paratype.—Snout to vent, 25, 24; width of head, 9.7, 9.7; length of head 10.3, 10.1; arm, 17, 17; leg, 49, 47; tibia, 16, 16; foot, 19.5, 20.

Variation.—The paratype differs but little from the type. It is a male with vocal sacs. The terminal pads on the toes and fingers are a trifle larger. The length of the eye (3.4 mm.) is about equal to the interval between eye and nostril, 3.2; the width of an eyelid is about the same as the interorbital width. The tibiotarsal articulation reaches the same distance beyond the snout as in type and the diameter of the tympanum (1.4 mm.) is less than half the diameter of eye. The height of the tympanum is a little greater than its width.

The color pattern, however, differs somewhat. The light dorsal coloration, pinkish in life (clay color in alcohol) reaches to the tip of the snout; the sides are a little darker and the underside of the femur and tibia is clouded rather than speckled with dark; the dorsal surfaces of femur and tibia are strongly barred with six brown lines, and when limbs are folded the lines are continuous on femur and tibia. The elevation on the top of the head is less distinct than in type.

Remarks.—The type was obtained from a bromelia, in a tree growing from lava rocks, in company with small salamanders also new to science. The paratype was obtained in camp early in the morning, while I was preserving specimens obtained the previous night. It hopped to within ten inches of my preserving pan.

A key is given herewith to assist in distinguishing the four Mexican forms of this group. The recently described *Eleutherodactylus xucanebi* Stuart is a member of this group.

KEY TO SPECIES OF THE ALFREDI GROUP OF THE GENUS ELEUTHERODACTYLUS

A. Vocal sac lacking; tympanum more than half (about ⅔) diameter of eye, usually brown with a lighter center; tibiotarsal articulation reaches much beyond tip of snout; Western Veracruz in the region about Córdoba.....*E. alfredi* Boulenger.

AA. Vocal sac present; tympanum less than half the diameter of eye, usually a little higher than wide, the upper part of tympanum usually blackish.

B. Tibiotarsal articulation reaching anterior edge of eye; above darkly mottled or spotted; usually one or two dark diagonal lines on side separated by a cream line; usually an inguinal black spot. Tips of three outer finger and three middle toes strongly emarginate (seen from above). Western Veracruz in the Córdoba region. Elevation about 2,500 ft. (See plate xxvii, figs. 7, 8, 11) .....*E. spatulatus* Smith.

BB. Tibiotarsal articulation reaching tip of snout or beyond. Emargination of disks less distinct.

C. Tibiotarsal articulation reaching much beyond the tip of the snout. Sides much darker than dorsum, which is reddish or pinkish in life; canthus rostralis distinct. A median elevated area on occiput and interorbital region. Between Las Vigas and Jalapa in Veracruz..*E. decoratus* sp. nov.

CC. Tibiotarsal articulation to tip of snout; sides are not darker than dorsum; canthus wanting or rounded. No elevated area on head. Body and sides colored alike. North Hidalgo. Elevation 4,000 ft.
E. hidalgoensis sp. nov.

Syrrhophus modestus sp. nov.

(Plate XXIX)

Type.—EHT-HMS No. 3756, collected at Hacienda Paso del Río, Colima, México, July 8, 1935 by Doctor Hobart M. Smith.

Paratypes.—EHT-HMS, Nos. 3754, 3755, 3757, 3758, collected by the same collector, same date and locality as type.

Diagnosis.—A very small species of the genus, maximum known length 21 mm. Tips of digits somewhat widened and truncate; tubercles very large; ventral disk rather indistinct; paratoid and inguinal glands present but rather indistinct; vocal sac present; eye shorter than its distance from the nostril; tympanum small, less than half the diameter of the eye; when limbs are folded at right angles to the body the heels fail to touch; tibiotarsal articulation reaches tympanum or between tympanum and eye. Skin smooth over dorsal, lateral and abdominal surfaces; interorbital distance more than double the width of an eyelid. Above generally yellowish brown or brownish gray, with an irregular broken lateral mark and several irregular dark spots on the back.

Description of the type.—Head broader than long; eye rather large, its length a very little less than its distance from the nostril, which is situated near the anterior edge of the snout; snout truncate extending but little beyond the mouth; interorbital distance double the width of an eyelid, equal to the length of the eye; tympanum not sharply distinct, its height a little greater than its width, the height more than one-third, but less than one-half of the eye length;

pupil of eye horizontal; canthus rostralis rounded, not distinct; loreal region oblique with a slight lateral depression behind nostril; tongue rather narrowed for half of its length anteriorly, then widened behind, but not emarginate, free behind for two-fifths of its length; vomerine teeth absent, the choanae widely separated, somewhat lateral and partly concealed by the overhanging jaw when seen from below; the palatal glands open in an indistinct groove between the middle of the choanae; premaxillae push down below the level of the maxillae, so that the premaxillary teeth jut down prominently.

Skin smooth on back, sides and venter, save in the inguinal region where the inguinal gland is outlined on the surface by pits and corrugations; a similar area slightly behind the tympanum outlining the paratoid gland; two small glandular tubercles at the lower posterior side of the tympanum, and a raised area above and somewhat behind the tympanum indicating, perhaps, a remnant of a supratympanic fold; tympanum indistinct, higher than wide, its height less than half of the length of the eye; vocal sac present as evidenced by ample folds of skin on the chin and breast, as well as by the vocal slits on the sides of the floor of the mouth, near the inner edge of the lower jaw; the greater part of the ventral and posterior face of the femur strongly granular; no trace of granules on the abdomen.

Limbs slender, the digits somewhat widened and truncate at the tip, the pads under the tips apparently but little developed; no trace of an interdigital membrane between fingers or toes; subarticular and supernumerary tubercles of hand strongly developed, with other small granules inserted between the tubercles; a very large prominent median palmar tubercle; no outer tubercle, the inner tubercle at the base of the first finger moderate; first finger only a little shorter than second; toes with very strongly developed subarticular and supernumerary tubercles; surface of foot between tubercles with minute granules. Inner metatarsal tubercle large, salient, its length equal to about half of the length of the first toe; outer metatarsal tubercle large, its summit directed forward. When the legs are placed at right angles to the body the heels do not touch; the tibiotarsal articulation reaches to near the posterior corner of eye.

Color.—Above generally yellowish brown with indistinct blackish spots; those on the dorsolateral region tend to form a broken longitudinal stripe, while those of the back tend to merge in the dorsal coloration; limbs and digits distinctly barred with blackish; loreal region dark, the upper lip light, this color extending up between the tympanum and the eye somewhat; the ventral surface, except for

the median abdominal region, with a fine powdering of pigment visible only under the lens; the throat has a little heavier pigmentation than the other ventral surfaces, except hands and feet, which are dark.

Measurements of *Syrrhophus modestus* sp. nov.

No.	3756	3757	3755	3758	3754
Sex	♂	♂	♂	♂	♂
Snout to vent	21	19	19.3	20	18
Width of head	7.6	7	7	7.1	6.7
Length of head	7.1	6.8	6.7	7	7.1
Diameter of eye	2.5	2.4	2.4	2.6	2.2
Snout to eye	2.7	2.6	3	3.3	3
Interorbital width	2.75	2.4	2.5	2.8	2.4
Upper eyelid	1.35	1.25	1.3	1.5	1.3
Foreleg	11.8	11.4	11.2	10.8	9.9
Hind leg	27	24.2	24.1	25.5	22.5
Tibia	8.3	8	7.2	8	7.2
Foot	11.8	10.5	9.9	11.3	11.5
Free part fifth toe	1.6	1.5	1.5	1.5	1.3
Free part fourth toe	4.1	4	4	4.4	3.8

Variation: The table of measurements shows some slight variations in measurements, but these are more apt to be due to the state of preservation than actual proportional differences. (If the eye is pushed down to the level of the head, it has apparently a greater length. Often the snout is apparently shortened by having been pressed against container.)

The tympanum is rather indistinct in all and in some the greatest diameter is about one third of the eye length. The snout is less truncate and more oval, extending a little farther beyond the tip of the upper lip, in one specimen.

The color does not differ, but the spots on the paratypes are often smaller and more numerous. These spots are irregular in size and position, often elongate, frequently confluent with others. The head usually lacks spots, but in one there is a slight suggestion of an interorbital bar, and there may be small flecks on the top of the head.

Hyla beltrani sp. nov.

(Plate XXVI, figs. 5 to 8)

Type.—EHT-HMS No. 29563; collected at Tapachula, Chiapas, August 1, 1941, by A. Magaña.

Diagnosis.—A medium sized hyla, the snout to vent length 44 mm.; tympanum about ⅔ eye; canthus rostralis distinct; dorsal skin smooth; inner metatarsal tubercle very large, salient, contained

twice in its distance from tip of first toe; outer tubercle very indistinct; a narrow tarsal fold; toes more than half webbed. Above grayish lavender, with scattered white spots; chin spotted; posterior face of thighs reticulated brown and cream; sides cream, spotted with lavender.

Description of type.—Head narrow, not wider than body; canthus rostralis distinct but slightly rounding, the lines of the canthus if projected, intersect slightly in advance of a line connecting nostrils; loreal region concave; width of interorbital region (4.7 mm.) much greater than width of an eyelid (3.2 mm.); intercanthal and interorbital regions as well as loreal region finely corrugated; tip of snout and lip smooth; diameter of tympanum (3.5 mm.) more than ¾ of eye (4.4 mm.)

Six vomerine teeth on raised triangular areas which lie directly between the large choanae, their anterior parts nearly reaching the anterior level, their posterior edges reaching the posterior level, of choanae. The areas are closely approximated medially, and separated from choanae by a distance a little more than half the width of one area; tongue large, somewhat cordiform, very slightly emarginate, its length equals its width, free for about ¼ to ⅓ of its length. The specimen is a female, and consequently lacks vocal sacs. (It is not known whether vocal sacs are present in the males.) The opening of the palatal glands in a sinuous groove, the ends of which curve down strongly.

Hand showing a small web at base of outer fingers, with first finger more or less opposed to other three; terminal pads moderately wide, those of three outer fingers slightly larger than the pads on toes; subarticlar tubercle of the outer finger is not divided; two outer palmer tubercles fused; inner tubercle at base of first finger, large, salient; surface of palm indistinctly granular; a few, very indistinct tubercles on under surface of arm. (Second finger of left hand amputated.)

Toes a little more than two-thirds webbed, the fourth toe rather short; inner metatarsal tubercle large, salient, somewhat compressed, its length contained twice in its distance from tip of first toe; outer metatarsal tubercle indistinct, reaching to upper level of inner; a distinct, narrow, tarsal fold; when limbs are folded at right angles, the heels touch or overlap very minutely; the tibiotarsal articulation reaches to nostril.

Skin on anterior part of head minutely corrugated, on back very smooth; sides of body and ventral surface of abdomen strongly

granular; chin and throat indistinctly granular; a faint fold across breast; anal flap very short, with a deep medial groove behind anus, and a few indistinct granules anterior to anal flap; a heavy fold begins behind eye, passes above tympanum and is continued as a broad skinfold to groin; an indistinct fold, branches down behind tympanun to a point above arm; pupil of eye horizontal.

Color.—Dorsal coloration lavender, with a few scattered creamy white spots; sides of body cream with numerous spots of dark lavender; chin cream, speckled with brownish lavender; abdomen cream; arms and legs lavender, indistinctly barred with darker color; anterior and posterior faces of femur cream with irregular brown spots or reticulations. Top of foot cream with brownish spotting; underside of foot and heel with much dark pigment; hand cream with very little pigment. Iris black, minutely flecked with silver.

Measurements in mm.—Snout to vent, 44; width of head, 16; length of head, 17; arm, 24; leg, 69; tibia, 22.5; foot, 30.

Remarks.—The exact relationship of this frog has not been ascertained since the type is a female and significant characters such as the presence or absence of the vocal sac, and nuptial callosities or spines are unknown. I believe, however, that it is related to *Hyla phaeota*. Only the single type is known.

I take pleasure in naming the species for Prof. Enrique Beltrán, noted Mexican parasitologist, who forwarded the specimen to me.

Hyla pachyderma sp. nov.

(Plate XXVII, figs. 1 to 4)

Type.—United States National Museum No. 115029; collected at Pan de Olla, south of Tezuitlán, Veracruz, México, by Dr. Hobart Smith.

Paratypes.—U. S. N. M. Nos. 115026-115028. Same data as type.

Diagnosis.—A medium sized hyla, lacking a vocal sac. Males with spiny nuptial callosities; skin very thick, glandular, smooth; tibiotarsal articulation to the anterior corner of eye; a breast fold present; vomerine teeth as close to the choanae as to each other; toes about three fourths (or slightly more) webbed.

Description of the type.—Head not wider than the body, short, a little wider than long; diameter of the eye (4.7 mm.) much less than length of snout (5.5 mm.); width of an eyelid (4.1 mm) equal to the interorbital width; canthus rostralis rounded; the loreal region somewhat concave between the eye and nostril; nostril equidistant from eye and the median anterior point of the upper lip; tympanum concealed by thick skin.

Vomerine teeth in two groups which lie between the large choanae, each group smaller than a choanae, separated from the choanae by a distance equal to that which separates the two groups; tongue subcircular, very slightly free behind (about one sixth of its length); palatal glands opening in a long sinuous groove, curving forwards laterally, and backwards medially, lying about midway between the vomerine teeth and the premaxillary.

Fingers without or with only a faint trace of webbing; terminal pads moderately widened; the first finger not opposed to the other three; distal subarticular tubercles large, the proximal ones small; supernumerary tubercles rather indistinct; median and outer palmar tubercles forming a combined tripartite tubercle; inner palmar tubercle large (first finger missing on left hand); a few indistinct pustules on the underside of the forearm. Leg moderate, the tibiotarsal articulation reaching between the eye and the nostril; a thickened, but at the same time rather indistinct, tarsal fold; toes between two thirds and three fourths webbed, the webs nowhere extending to the disks save as narrow margins; a moderately large inner metatarsal tubercle, sharply compressed on its inner edge; a free flap of skin on the inner edge of the first toe to the tubercle, and a similar flap on the two distal joints on the outer side of the fifth toe; numerous supernumerary tubercles, small and indistinct, and a small indistinct outer metatarsal tubercle; the terminal disks of the toes are smaller than those of the fingers.

Skin of the back thickened, glandular, however presenting a surface that is nearly smooth; a very strong thickened fold from the eye to above the arm insertion, curving partly over the tympanic region; chin, abdomen and most of the under surface of the femur with large granules; a fold across the breast interrupted medially; anal flap somewhat elongated, with a thickened fold running diagonally from the sides of the anus.

Color.—Above dark lead to grayish lead, the hands and feet lighter, especially the hidden parts of the digits; venter bright lemon yellow, with grayish black mottling or reticulations; chin marbled black; a few yellowish or cream flecks on the sides; part of the breast and the underside of the arms cream; a transverse series of cream spots anterior to the anus, and two somewhat elongate spots posterior to the anus; posterior face of the femur darker than the venter.

Measurements in mm.—Snout to vent, 49; width of head, 15.2; length of head, 13.3; arm, 32; leg, 72; tibia, 25; foot, 37.

Variation.—The male lacks vocal sacs, and bears a large nuptial

callosity covered with blackish horny spines. These are similar in shape to those of *Hyla robertsorum* but are very considerably larger and heavier. A row of the spinules is present on the inner edge of the second finger, and a few spinules are present on the third, at the base of the disk. The male is considerably lighter on the venter.

The row of cream spots anterior to the anus may be continued across the posterior face of the femur; the posterior side of the foot may show a number of light spots.

Remarks.—This species is related to *Hyla robertsorum* of Hidalgo, and *Hyla robustofemora* of Oaxaca. All have the glandular skin, the spiny nuptial callosities and all lack the vocal sac. When the skin is cut the glands appear as small spherical objects, set closely together, cream or yellow in color. When examined on the surface, under a lens, the skin of the dorsal and ventral surfaces shows small deep yellow spots.

The three species may be easily separated by the following key:

A. Tympanum small, exposed; toes about three-fourths webbed. High mountains of Hidalgo ..... *H. robertsorum* Taylor.

AA. Tympanum concealed.

B. Toes fully webbed; nuptial callosities similar to those of *robertsorum* but usually darker. Cerro San Felipe, Oaxaca, Oaxaca.... *H. robustofemora* Taylor.

BB. Toes about three-fourths webbed. Spinules of the nuptial callosities more than double the size of either of the two preceding species. Pan de Olla, Veracruz ..... *H. pachyderma* sp. nov.

Specimens of an undescribed frog were collected by Dr. Hobart M. Smith near Chapala, Jalisco, Mexico, during the summer of 1935, at which time a series of ten young and middle-aged specimens were obtained. Later, in 1939, he collected a second series at La Palma, Jalisco. Among this lot of eight specimens two were young while the others were very large adults.

This form is a member of the group of species which includes *Rana montezumae, Rana areolata,* and *Rana pipiens,* a group characterized by the presence of lateral vocal sacs which protrude behind the angle of the mouth, below the tympanic region.

Rana megapoda sp. nov.

(Plate XXVIII, figs. 1 and 2)

Type.—Edward H. Taylor-Hobart M. Smith collection, No. 3280; collected near Chapala, Jalisco, July 2, 1935, by Hobart M. Smith.

Paratypes.—EHT-HMS Nos. 3271, 3272, 3272A, 3273-3279, topotypes; U. S. National Museum Nos. 113998-114005, La Palma, Lake Chapala, March 23, 1939, Dr. and Mrs. Hobart M. Smith.

Diagnosis.—Hands and feet very large, the first finger equal to or shorter than the second; second and fourth nearly equal and but little shorter than third; toes webbed to the tips, which terminate in small but distinct rounded pads; skin of back generally smooth; tympanum small; heels do not touch; belly reticulated with dark color inclosing lighter spots.

Description of type.—Head moderately depressed, the loreal region very oblique, not concave; nostril equidistant between eye and tip of snout; head oval, seen from above, the canthus rostralis faintly indicated from eye to nostril; sides of head back of eye very oblique; interorbital width about two-thirds the width of an eyelid; length of the eye more than three-fourths the length of the snout; distance between tympanum and eye equal to distance from eye to nostril; diameter of tympanum about equal to its distance from eye; length of head to jaw angle, a little greater than head width at jaw angle. Tongue longer than wide, with two posterior papillate horns, free for about one-fourth of its length; choanae very small, transversely elongate; vomerine teeth on two rounded elevations almost wholly behind a line drawn between the choanae; the elevations much closer to each other than to choanae, each bearing five teeth; openings of the palatal glands in a straight series, midway between the vomerine teeth and the premaxillae.

Arms strong, thickened, the wrist brought forward reaches the tip of the snout or beyond; palm broadened, the fingers alongate, straight, the first not extending beyond the second, but equal to, or minutely shorter than second; second minutely shorter than fourth; third toe relatively short in proportion to others; the second and third fingers have a slight fold or ridge along the sides of their distal joints, while the first and fourth have a slight indication of a fold or ridge on the inner side of the distal joints. A small palmar tubercle on the base of the first finger; other palmar tubercles obsolete; subarticular tubercles small. Legs large, the femoral region much thickened. When the legs are folded at right angles to body the heels fail to touch by five or six millimeters; tibiotarsal articulation reaches the anterior corner of the eye. Toes almost entirely webbed, the membrane extending to the rounded terminal pad, at least on one side of the digit; outer edge of the fifth toe and the inner edge of the first with a free skin flap or fold; a distinct elongate flattened inner metatarsal tubercle, with a free outer edge; no outer metatarsal tubercle; a widened fold forms a somewhat diagonal line on the tarsus; subarticular tubercles very small, usually about half the size of the terminal pads.

Skin generally smooth on back; however, posteriorly, there are some smooth indistinct pustules; these flattended pustules are more or less evident on sides of body, and along the tibiotarsal surface. A broad dorsolateral fold begins behind the eye and continues to near the groin, passing above the tympanum.

Color.—Above and on sides grayish with indistinct fine blackish reticulation, and a few scattered elongate black spots; ventral surface cream with an indistinct brownish or grayish reticulation; limbs gray with larger black spots or transverse bars; feet somewhat darkened; dorsolateral fold cream.

Measurements of Rana megapoda in mm.

	Type						
Number	3280	113998	114001	114002	114005	114004	114003
Sex	♀	♂	♀	♀	♀	♀	♀
Snout to vent	82.5	117	130	142	146	148	152
Head length*	31.5	44	47.5	54	52	53.5	53
Head width	31	46.5	52	56	58	59	59
Snout length	9.2	11	12.2	14	15.4	16.2	14.5
Eye length	7.5	10	12	12.2	11	12.4	11
Interorbital width	3.6	5.5	7	6.8	7.8	7	8
Tympanum	5.9	7	9	9	9	9	10
Arm length	37.3	72	87	100	98	88	104
Leg	139	195	212	224	220	226	240
Tibia	41.4	58	62.5	68	69	72	75
Foot	64.3	87.5	97	101	103	103	110
Heel to 1st toe	36	55	59	60.5	64	62	69
Heel to 2d toe	45.6	66	73	78	80	78.8	80
Heel to 3d toe	54.4	76	86	93	92.5	93	96
Heel to 4th toe	64.3	87.5	97	101	103	103	110
Heel to 5th toe	53.3	77	85	86	90	88	96

Variation.—The dark reticulation on the ventral surface of larger specimens is more distinct than in type, inclosing very numerous small irregular spots of cream. In certain specimens the hands and feet are blackish, punctated with cream. The single male specimen is uniformly reticulated on the back and has only a single black spot; the limbs are, however, rather heavily spotted. In several specimens the dark spots are bordered by lighter color. The dorsolateral fold usually has the color of the back in the larger specimens.

The dorsolateral fold usually terminates before the groin is reached, although one specimen shows it continued back farther. There is only a faint suggestion of a posttympanic fold and this in

* Measured to jaw angle; width measured between angles of jaws.

only a part of the specimens. Some of the specimens have a few smooth tubercles behind the angle of the jaw. The smooth granulation on the sides of the body seems to be invariably present in larger specimens. The size of the terminal enlargements on the digits varies a little; however, they are often deformed or worn away. In younger specimens the head is a little longer than wide while in the older specimens the width is greater than the length.

The tympanum has an irregular shape, and its greatest diameter is usually equal to its distance from the corner of the eye in both sexes.

Remarks.—Rana megapoda is found in a region where *Rana montezumae* likewise occurs, and it seems almost certain that specimens that have been taken by other collectors have been referred to *R. montezumae* by various authors. The differences, however, between these two species are numerous. If specimens of the two species, having equal snout to vent measurements, are compared, it will be found that the head of *montezumae* is much shorter and narrower, the snout longer, the eye a little larger, the interorbital width a little greater, the tympanum much larger, the arm and hand shorter and more slender and the fingers smaller, with the first longer than the second. The leg, as well as its parts, is very much shorter, while the fourth toe is proportionally longer than the other toes. The skin of the back and sides will be rough and granular.

I believe *R. megapoda* to be a very much larger species than *R. montezumae*. Boulenger (Proc. Amer. Acad. Arts and Sci., 55, 1920, pp. 431-433) lists certain specimens as *Rana montezumae* measuring from snout to vent, 145, 140, and 136 millimeters, from "Lazuna del Castillo," Guadalajara. These, however, I suspect belong to *megapoda*. His description gives ample evidence that he has confused the two species.

The largest of 52 specimens of *Rana montezumae* in the EHT-HMS collection measures only 116 mm.

PLATE XXV

FIG. 1. *Eleutherodactylus decoratus sp. nov.* Type, EHT-HMS No. 28720 ♀, Banderia, Veracruz. (Actual snout to vent length, 25 mm.)

FIG. 2. Same, lateral view of the head, enlarged.

FIG. 3. Same, under surface of foot, enlarged.

FIG. 4. Same, under surface of hand, enlarged.

FIG. 5. *Eleutherodactylus hidalgoensis sp. nov.* Type, EHT-HMS No. 24454 ♂, North of Tianguistengo, Hidalgo. (Actual snout to vent length, 28.5 mm.)

FIG. 6. Same, lateral view of head, enlarged.

FIG. 7. Same, under surface of foot, enlarged.

FIG. 8. Same, under surface of hand, enlarged.

Plate XXV

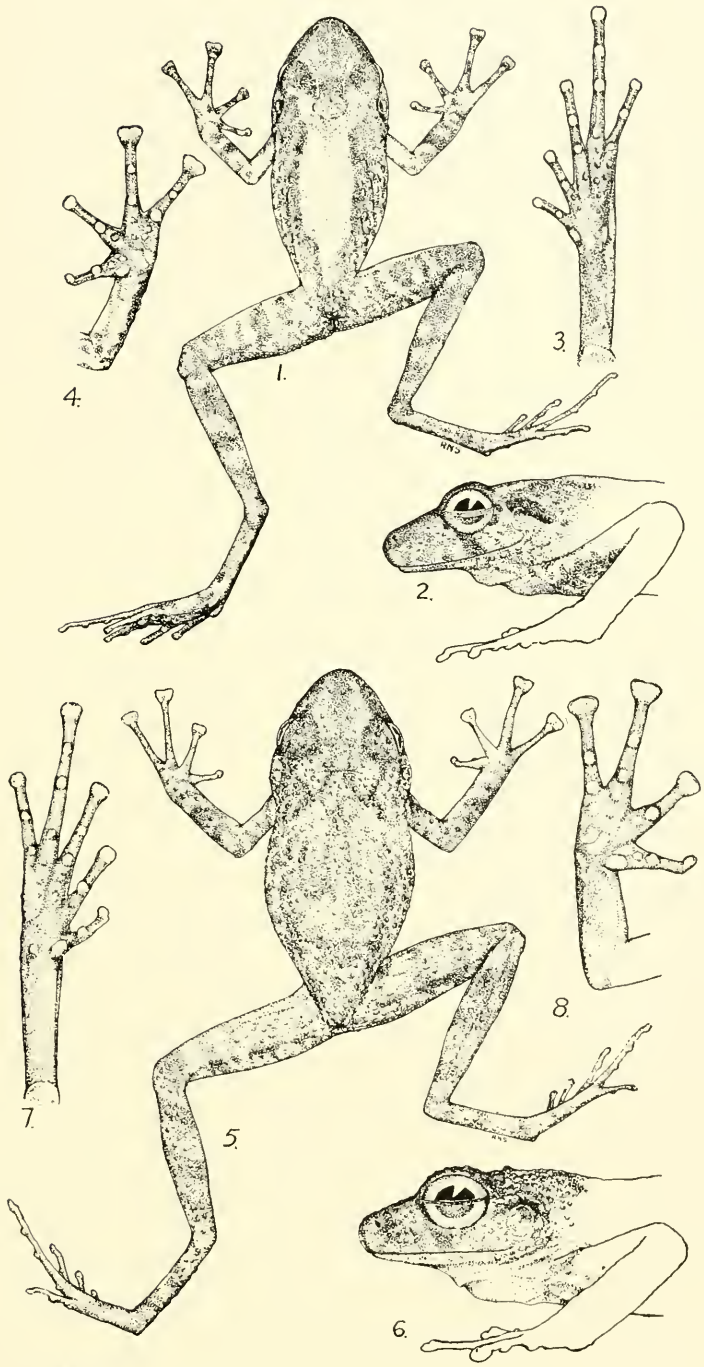


Plate XXVI

FIG. 1. *Eleutherodactylus bolivari sp. nov.* Type, EHT-HMS No. 29564 ♂, Ixtapan del Oro, México. (Actual snout to vent length, 44 mm.)

FIG. 2. Same, lateral view of head, enlarged.

FIG. 3. Same, under side of hand, enlarged.

FIG. 4. Same, under side of foot, enlarged.

FIG. 5. *Hyla beltrani sp. nov.* Type, EHT-HMS No. 29563, Tapachula, Chiapas. (Actual snout to vent length 44 mm.)

FIG. 6. Same, lateral view of the head, enlarged.

FIG. 7. Same, under side of the foot, enlarged.

FIG. 8. Same, under side of the hand, enlarged.

Plate XXVI

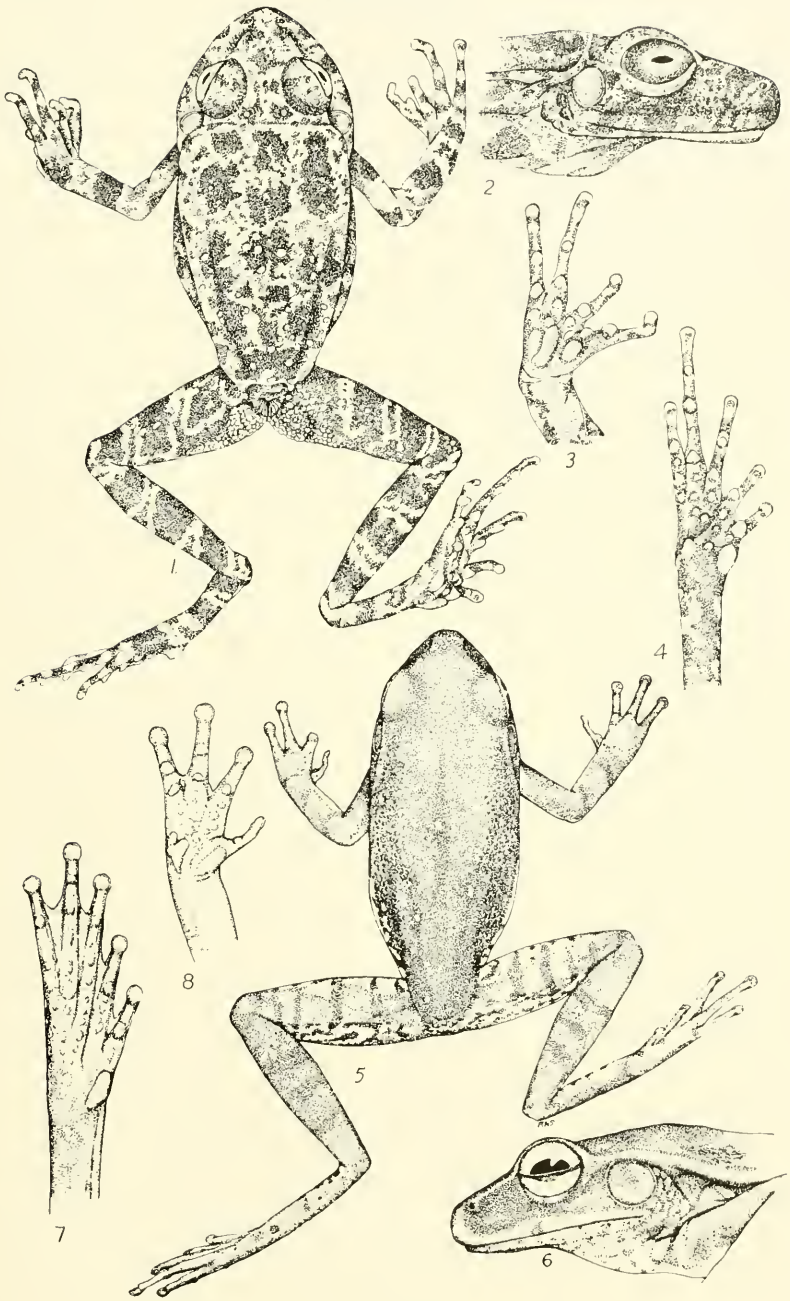


Plate XXVII

FIG. 1. *Hyla pachyderma sp. nov.* Type, USNM No. 115029 ♀, Pan de Olla, near Tezuitlán, Veracruz. Under side of foot, enlarged. (Actual length of foot, 37 mm.)

FIG. 2. Same, under side of hand. (Actual length of hand and forearm, 18.6 mm.)

FIG. 3. Same, spinules on the nuptial callosities. (Much enlarged.)

FIG. 4. *Hyla robertsorum* Taylor, spinules on the nuptial callosities, enlarged as in the preceding, showing the much smaller size.

FIG. 5. *Bolitoglossa lavae sp. nov.* Type, EHT-HMS No. 28937 ♀. Two miles west of La Joya, Veracruz. Dorsal view of foot. (Actual length of foot and tibia, 8 mm.)

FIG. 6. Same, dorsal view of hand and forearm. (Actual length, 7 mm.)

FIG. 7. *Eleutherodactylus spatulatus* Smith, EHT-HMS No. 24444. Under side of hand, enlarged. (Actual length of hand and forearm, 17 mm.)

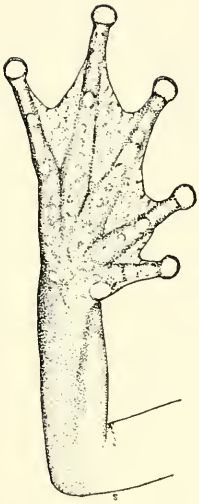
FIG. 8. Same, under side of foot. (Actual length of foot and tarsus, 30 mm.)

FIG. 9. *Eleutherodactylus decoratus sp. nov.* Tips of digits of foot and hand, enlarged. (Specimen 25 mm. snout to vent.)

FIG. 10. *Eleutherodactylus hidalgoensis sp. nov.* Tips of digits of foot and hand, enlarged. (Specimen 28.5 mm. snout to vent.)

FIG. 11. *Eleutherodactylus spatulatus* Smith. Tips of digits of foot and hand, enlarged. (Length of specimen, 27 mm. snout to vent.)

Plate XXVII



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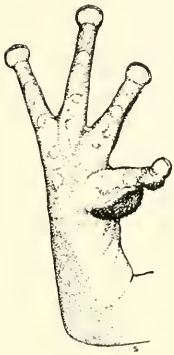

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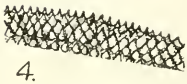

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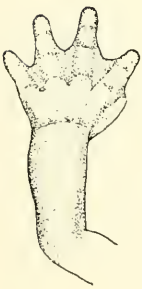

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Plate XXVIII

FIG. 1. *Rana megapoda sp. nov.* Paratype, EHT-HMS No. 3271. Near Chapala, Jalisco. (Snout to vent length, 68 mm.)

FIG. 2. Same. Type, EHT-HMS No. 3280, same locality. (Snout to vent length, 82.5 mm.)

Plate XXVIII

Plate XXIX

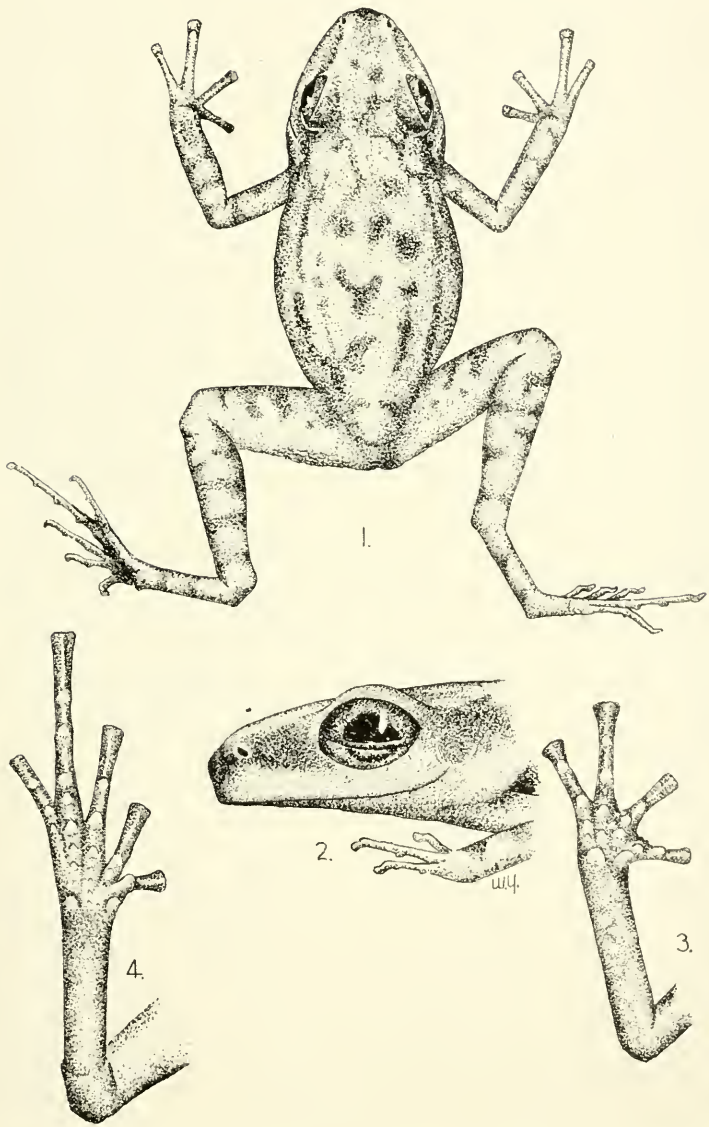
FIG. 1. *Syrrhophus modestus sp. nov.* Type, EHT-HMS No. 3756, Hacienda Paso del Río, Colima, × 3.

FIG. 2. Same. Lateral view of head, × 5.

FIG. 3. Same. Underside of hand, × 5.

FIG. 4. Same. Underside of foot, × 5.

Plate XXIX



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The Snake Genera *Conopsis* and *Toluca*

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ABSTRACT: A review of the genera *Conopsis* and *Toluca*, shows the following recognizable forms: *Conopsis nasus* Günther and *Conopsis biscrialis* sp. nov. (type locality 10 miles W. Villa Victoria, México). *Toluca megalodon* sp. nov., Cerro San Felipe, Oaxaca, *Toluca conica* sp. nov., San Juan Guivini, Oaxaca, *Toluca lineata lineata* Kennicott, *Toluca lineata varians* (Jan), *Toluca lineata acuta* (Cope). All forms are figured.

THE group of small snakes that has been variously referred to the genera or subgenera *Conopsis* Günther, *Pseudoficimia* Bocourt, *Toluca* Kennicott, *Oxyrhina* Jan, *Achirhina* Jan, *Exorhina* Jan, *Epirhina* Jan, *Ogmius* Cope (and by some authors placed in the recognized genera *Contia*, *Ficimia* and *Chionactis*), has not been represented heretofore by specimens in sufficient numbers or from a sufficient number of localities to evaluate properly the status of the generic or specific names that have been assigned. Even at the moment, although more than 800 specimens are before us,* some of the species are represented by adequate series while others are represented by far too few specimens to be able to make unequivocal assignments. Moreover, certain of our conclusions must perforce be of a tentative nature, pending examination of the types now in European museums.

The following generic or subgeneric names have been proposed:

1858 *Conopsis* Günther. Cat. Col. Snakes, p. 6. Type, *Conopsis nasus*.

1859 *Toluca* Kennicott. In Baird, U. S. and Mexican Bound. Surv., II, Rept., p. 23. Type, *Toluca lineata*.

* We wish to acknowledge the courtesy of the United States National Museum, University of Michigan Museum of Zoölogy, Field Museum of Natural History, Chicago Academy of Sciences, American Museum of Natural History, and the Museum of Comparative Zoölogy, in the loan of specimens.

1862 *Oxyrhina* Jan (non Agassiz). Arch. Zoöl. Anat. Fis., II, Fasc. I, pp. 59-60. Type, *Oxyrhina varians*.

1862 *Achirhina* Jan (subgenus). *Loc. cit.*, p. 61. Type, *Achirhina De Filippii* = *Toluca lineata* Kennicott (no separate generic description).

1862 *Exorhina* Jan (subgenus). *Loc. cit.*, p. 61. Type, *Exorhina maculata* (no separate generic description).

1862 *Epirhina* Jan. *Loc. cit.*, pp. 62-63. Type, *Epirhina tessellata* (no separate generic description).

1869 *Ogmius* Cope. Proc. Amer. Philos. Soc., II, 1869, p. 162. Type, *Oxyrhina varians* Jan. Proposed as a substitute for *Oxyrhina* Jan, preoccupied.

The following species have been listed or described:

1857 *Stenorrhina varians* Jan, Sist. Rett. Anf. Milano (Cenni sul Museo Civico di Milano), p. 48. *Nomen nudum*.

1857 *Stenorrhina de Filippii* Jan, Sist. Rett. Anf. Milano (Cenni sul Museo Civico di Milano), p. 48. *Nomen nudum*.

1858 *Conopsis nasus* Günther, Cat. Snakes Brit. Mus., p. 6. Type locality "California."

1859 *Toluca lineata* Kennicott, in Baird, Reptiles of the U. S. Mex. Bound., pp. 23-24. Type locality, "Valley of Mexico."

1862 *Oxyrhina varians* Jan, Arch. Zoöl. Anat. Fis., II, Fasc. I, pp. 60-61. Type locality, "Messico."

1862 *O.[xyrhina] (Achirhina) de Filippi* Jan, Arch. Zoöl. Anat. Fis., II, Fasc. I, p. 61. Type locality "Messico." (= *Toluca lineata;* the frontal separates the prefrontals).

1862 *O.[xyrhina] (Exorhina) maculata* Jan, Arch. Zoöl. Anat. Fis., II, Fasc. I, pp. 61-62. Type locality, "Messico."

1862 *Epirhina tessellata* Jan, Arch. Zoöl. Anat. Fis., II, Fasc. I, pp. 62-63. Mexico?

1869 *Oxyrhina maculata anomala* Dugès, La. Nat., I, p. 144. *Nomen nudum*. Locality cited, Guanajuato.

1886 *Ogmius acutus* Cope, in Ferrari-Perez, Proc. U. S. Nat. Mus., IX, p. 189. Type locality, "Tuchitan on the Pacific side of the Isthmus of Tehuantepec."

1930 *Conopsis nasus heliae* Terron, Anal. Inst. Biol. Mexico, I, pp. 175-176, fig. 1. Type locality, San Luis Potosí, S. L. P.

The first genus and species of this group to be described was *Conopsis nasus* Günther, in the Catalogue of Colubrine Snakes in the Collection of the British Museum, 1858. The source of the type was recorded as "California, from Mr. Bridges' collection." Since this record is the only one for the occurrence of the species in California we believe that some error has occurred in the data.*

Because of this almost certain error, we are confronted with the necessity of assigning the name *Conopsis nasus* to some Mexican

* We have endeavored to ascertain whether other specimens collected by Mr. Bridges could throw any light on the probable type locality. We find that *Ablabes purpureocauda* (= *Contia mitis* Baird and Girard) described by Günther in the "Catalogue" is from California. In the "Catalogue of the Lizards of the British Museum" by Boulenger, the following specimens purporting to have been collected by Mr. Bridges are listed: *Gerrhonotus caeruleus*, California, *Iguana tuberculata*, W. Coast of America," *Lepidosternon phocaena*, S. America, *Liolaemus lemniscatus*, Chile; and *Liolaemus chilensis*, Chile. In the Günther "Catalogue of the Batrachia Salientia etc.," *Pleurodema bibroni*, and *Bufo chilensis* are recorded from Chile.

It will thus be seen that save for a Mexican species in the list, there is nothing which throws much light on the provenance of the type specimen.

form, without the aid of locality data. This entails some difficulty, since there is more than one form to which the description might apply. A careful analysis of the data offered in the type description and the drawing of the type given by Günther (1893) point to the conclusion that the name should be associated with a form occurring in the western plateau region. Only a single specimen was available to Günther when the generic and specific descriptions of *Conopsis nasus* were drawn up. We quote the description:

CONOPSIS, *Günther*

"Body and tail moderate. Only one pair of frontals; rostral shield protruding, pyramidal, slightly bent upwards; one nasal, pierced by the nostril; loreal none, united with the frontal; one anterior, two posterior oculars; seven upper labials. Scales smooth, rounded behind, in seventeen rows; anal bifid; subcaudals two-rowed. Teeth equal, smooth. California.

1. CONOPSIS NASUS

Uniform dark olive; on the anterior part of back some small black spots; beneath paler, with black spots.

a. California. From Mr. Bridges' collection.

Description of the specimen.—Head rounded, conical, sharply pointed in front, not distinct from neck; body cylindrical, rather compressed; tail not distinct, stout, tapering; eye moderate, pupil round. Rostral shield forming a solid, protruding, four-sided pyramid with rounded edges, the top of which is slightly bent upwards (somewhat similar to the same shield in *Rhinostoma*, but without sharp ridge); upper jaw much longer than lower; mouth moderately cleft; only one pair of frontals, large, six-sided, bent on the sides; vertical very large, longer than broad, six-sided, with an obtuse angle in front, and an acute one behind; superciliaries elongate; occipitals rather large, rounded behind; one nasal, pierced by a very small nostril, in direct contact with the anteocular; one anterior ocular, not raised on the surface of crown; two posterior oculars; loreal none; seven upper labials, third and fourth forming the lower edge of orbit; one large elongate temporal, in contact with both hinder oculars, some scale-like shields behind; first pair of lower labials forming a suture behind the terminal shield; two pairs of chin-shields, the anterior one largest, each half irregularly five-sided, twice as long as broad. Scales smooth, rather short, rounded at the tip, in seventeen rows; ventral plates 118, anal bifid, subcaudals 38. Nearly uniform dark olive; on the anterior part of back some obsolete black spots; sides lighter; belly yellowish white; edges of each ventral plate with two or three black spots. Length of cleft of mouth, ¼″; length of tail, 2″; total length, 10″."

There are three species to which this name might apply. Two are forms occurring in Oaxaca and Guerrero, while the third is known from Chihuahua, Zacatecas, Durango, San Luis Potosí, Guanajuato, Michoacán, Jalisco, México and Distrito Federal. These three apparently are very distinct species. The last species is characterized by being very much the larger, reaching a length of more than 350

mm. while more than 13 percent of the specimens seen are more than 300 mm. The southern species are apparently smaller; only a single specimen out of 20 examined measures over 300 mm. (310 mm.). The species differ also in the character of the teeth and in marking and pigmentation. The larger northern species has the maxillary teeth equal, and while there is a slight posterolateral ridge on the posterior maxillary teeth, there is no groove. In the southern species the posterior teeth are enlarged and have a shallow or deep grove. The tip of the snout does not "turn up" normally in the northern species but a specimen that is allowed to remain some time out of the preserving fluid, tends to develop a rostral depression which gives it the appearance of being turned up. In the northern species the loreal is variable. In specimens from San Luis Potosí it is present in most cases, but in the Michoacán region the loreal is very frequently wanting. In these specimens we believe that the loreal has been fused to the nasal, rather than to the prefrontal, since the nasal is elongated and normally touches the preocular. When the loreal is present it separates the nasal and the preocular.

An examination of Günther's figure suggests that the loreal is fused to the nasal, and not "united with the frontal" (prefrontal). The temporal in this form is "elongate" much more so than in the southern species. The ventral and subcaudal scale counts, 118-38* is closely approached by that of a male specimen from Pátzcuaro, with 119-37. The average counts of the northern species is higher, however.

Concerning the character of the teeth of *Conopsis nasus* Günther (*loc. cit.*, 1893, p. 97) states, "The snakes of this genus are not strictly isodont. The posterior teeth are always somewhat stouter, if not longer than the anterior, which is particularly conspicuous in specimens exceeding ten inches in length. In specimens of that size sometimes a distinct elongate pit at the base of the tooth may be seen, apparently the commencement of a groove." At the time the above was written Günther had available a number of specimens, and it would appear that he confused two or more species under the name of *nasus*. We do not regard it a contradiction of the statement, "Teeth equal, smooth" of the type description.

In the two southern species, the posterior teeth are much enlarged, and there is either a shallow or deep groove.

* Boulenger, *loc. cit.* says, ventrals 131; subcaudals, 35, for the male type specimen. These counts are probably erroneous.

We must conclude that the name *nasus* is applicable to the northern form which lacks internasals, that has maxillary teeth that are not enlarged posteriorly, and that has an elongate anterior temporal.

Genus Conopsis Günther

This genus may be defined as follows: small, burrowing snakes, with internasals present or absent (fused to the prefrontals); the rostral shield more or less protruding, pyramidal, slightly bent upwards; nostril piereed in the single nasal; loreal present or absent (united to nasal, lower labial or prefrontal); one preocular, two postoculars; temporal formula 1 + 2; seven upper labials; posterior maxillary teeth not enlarged, their posterior edges laterally depressed; scales smooth, in seventeen rows, with rather indistinct apical pits. Anal and subcaudals divided.

KEY TO THE SPECIES OF CONOPSIS GÜNTHER

A. Internasals and prefrontals fused; a median row of small spots above; venter with dark spots irregular or paired; Southern Chihuahua to Central Michoacán, eastward to southern central San Luis Potosí and Distrito Federal....*Conopsis nasus* Günther

AA. Internasal and prefrontal separate (normal'y); a paired series of dark spots or a tessellated pattern above; spotted or not below; Michoacán, México, Morelos and Distrito Federal.....*Conopsis biscrialis* sp. nov.

Conopsis nasus Günther

(Pl. XXX, figs. 2, 3; XXXII figs. 2, 3, 4; pl. XXXV, fig. 4; text fig. 1)

Conopsis nasus Günther, Cat. Col Snakes British Mus., London, 1858, pp. 6-7 (type description; type locality, "California" [in error]); Peters, Mon. Preus. Akad. Wiss., Berlin, Dec., 1869 (1870)), p. 875 (*part.*); Bocourt, Miss. Sci. au Mexique et l'Amérique Central, étude sur les Reptiles, Livr. 9, 1883, pp. 563-564, pl. XXXV, figs. 2, 2a-2d (México); Cope, Amer. Nat., 18, Feb., 1884, p. 162 (synonymizes *Exhorhina* [sic] *maculata* Jan with *Conopsis nasus* Günther); and Bull. U. S. Nat. Mus., 2, 1887, p. 82 (*part.*); Günther, Biologia Centrali-Americana, Rept. Batr., Aug., 1893, p. 97 (*part.*), pl. XXIV, figs. B and B" (Milpas, Durango; La Cumbre de los Arrastrados, Jalisco); Dugès, Mem. Gob. Guanajuato, 1895, p.? (Guanajuato); and Mem. Soc. Cient. Antonio Alzate, 9, 1895-1986 (1896), pp. 409-413, pl. 5 (*part.* same content as preceding article, but in French rather than Spanish); Cope, Amer. Nat., 30, 1896, p. 1021 (listed as occurring in Austrocentral District); and Rep. U. S. Nat. Mus., 1898 (1900), pp. 934-935, 1229 (*part.*); Dugès, La Naturaleza, Ser. 2, 2, 1896, p. 481 (Tanganzícuaro, Guanajuato, Moro León, Zacatecas); Herrera, Cat. Rept. Batr. Mus. Nac. Mexico, Ed. 2, 1904, p. 30 (México); Amaral, Mem. Inst. Butantan, Vol. 4, 1929, p. 182; Werner, Zoöl. Jahrb., 57, 1929, p. 149 (*part.*); (México); Dunn, Proc. Acad. Nat. Sci. Phila., 1936, p. 477 (Alvarez, S. L. P.); Taylor and Knobloch, Proc. Biol. Soc. Wash., 53, 1930, pp. 128-129 (Chihuahua, Michoacán, Jaliseo, Guanajuato, Durango).

Oxyrhina (*Exorhina*) *maculata* Jan, Arch. Zoöl. Anat. Fis., 1862, 2, pp. 54, 61-63 (type description; type locality, "Messico").

Oxyrhina maculata Jan, Elenco. Sist. Ofid., 1863, p. 41 (Mexico) (*part.*); J. W. Müller, Reisen Ver. Staat. Can. Mex., 1865, p. 606; Jan, Icon. Gen., Livr. 48, 1876, pl. 2, figs. 2-4 (*part.*); Garman, Bull. Essex Inst., 1884, 16, p. 30 (México); Herrera, Cat. Rept. Batr. Mus. Nac. Mexico, Ed. 2, 1904, p. 30 (México).

Oxyrhina maculata anomala Dugès, La Naturaleza, 1869, p. 144 (Guanajuato; *nomen nudum*).

Ficimia maculata Garman, Mem. Mus. Comp. Zoöl., 8, 1883, pp. 84, 162 (Mexico; redescription).

Conopsis maculatus Cope, Amer. Nat., Feb., 1884, p. 162; Dugès, Elem. Zoöl., 1884, p. 336; Bocourt, Miss. Sci. Mex. Cent. Amér., étude Rept., Livr. 9, 1883, pp. 564-565, pl. 35, fig. 3.

Contia nasus Boulenger, Cat. Snakes British Museum, 2d Ed., Vol. 2, 1894, pp. 268-269 (*part.*); Boettger, Kat. Rept. Senck. Mus., 2, 1898, p. 77 (México, Jalisco, 8,500 ft.); Gadow, Proc. Zoöl. Soc. London, 1905, pp. 196, 233 (*part.*; Contreras, D. F.); and Zoöl. Jahrb., 29, 1910, p. 707; and Jorullo, 1930, p. 50 (Michoacán, above 3,500 ft.).

Conopsis [*nasus nasus*] Terron, Anal. Inst. Biol. Mex., 1, 1930, p. 176 (Tepéxpam, México; "Especie tipo").

Conopsis nasus heliae Terron, Anal. Inst. Biol. Mex., 1, 1930, pp. 175-176 (San Luis Potosí, S. L. P.).

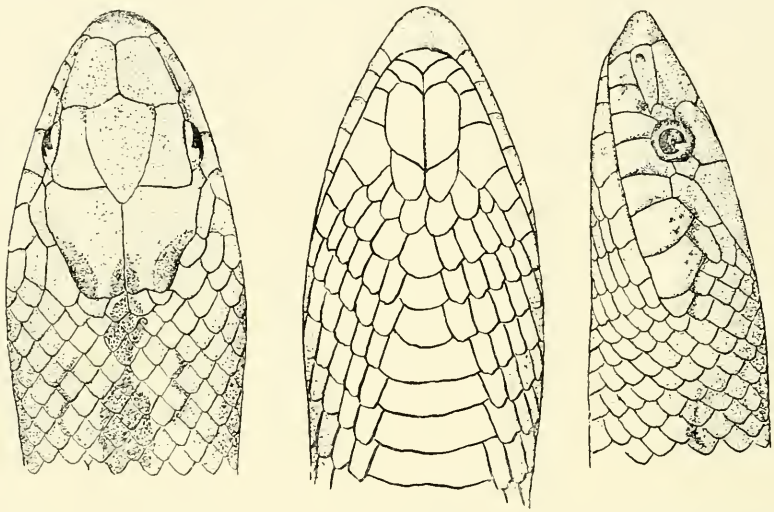


FIG. 1. *Conopsis nasus* Günther. EHT-HMS No. 21415, 5 miles East Lake Pátzcuaro, three views of head. × 3.

(Since the type description is given no synopsis of this form is offered.)

Variation.—The variation observed in the 175 specimens that have been available for study, has been considerable. This material may be divided into three geographical groups: Alvarez (southern San Luis Potosí), northern Michoacán and Guanajuato, and Distrito Federal.

In color and markings the first two groups are very similar, save that in specimens from the northern locality the median line of dots is somewhat less distinct. In the specimens from the Distrito Federal the median spots are much enlarged, covering 8 to 15 scales (instead of parts of four scales). Apparently it is a specimen of this sort that is the type of *Oxyrhina maculata* Jan.

The variation in the ventral scutellation may be summed up as follows: Alvarez (125 specimens) males, ventrals 118-127; subcaudals 30-37; average 122.6-32.9; for females, 122-132, 22-27, av-

erage 127.2 and 24; data taken on the more southern and western specimens show the males to have a range of 119-133; 30-38; average 126.3 and 33.2; females 124-137; 22-31; average 132.1 and 26.

The loreal variation is considerable. In the 125 Alvarez specimens it is absent in 6 out of 250 times. In 20 specimens from Michoacán the loreal is absent in 28 out of 40. In five Guanajuato specimens it is absent only once in 10 times. It is present in the single specimens from Zacatecas and Chihuahua. In the nine specimens from Distrito Federal, the loreal is absent in five out of 18 times.

The internasals are normally wanting in the entire series from all localities, but in a few specimens there is either partial or complete segmentation; in one case there is complete segmentation on one side and none on the other, and eight cases out of a possible 348 there is partial segmentation. A few other anomalies have been observed: a fusion of a parietal and a postocular on one or both sides; the entrance of the second labial into the orbit; the splitting of the anterior end of a supraocular, and a median longitudinal scale on the snout. In most cases these have been found but once. With regard to the tendency in certain specimens of the prefrontal to split, we do not regard this as evidence of intergrading with *biserialis* which has the prefrontal normally separated from the internasal.

The maxillary teeth number 13 or 14, and are uniform in size, none with grooves; 9 palatine teeth, slightly smaller than the maxillary teeth; 12 pterygoid teeth, larger than the maxillary teeth; and 15 dentary teeth.

The hemipenis is 11 or 12 caudals long; 4 or 5 basal caudal lengths spineless, ridged; distal to this point large spines begin and extend toward the tip, covering all except the terminal 2 or 3 caudal lengths; the spines in the basal four caudal lengths number about 34; numerous, exceedingly minute spines are scattered amongst the larger spines; the spines decrease in size distally and merge with the papillae bordering the large terminal calyces; latter in 4 to 6 rows, covering the terminal 2 or 3 caudal lengths.

Whether it will be possible to recognize as a subspecies the large spotted form from Guanajuato and Distrito Federal will depend upon larger series of specimens, a series which will show a continuity of distribution and constancy of character.

The subspecies *nasus heliae* was erected for a group of specimens from the neighborhood of San Luis Potosí (city) said to have two

preoculars. In the material we have examined we find this anomaly occurring on one side of a specimen from Alvarez, San Luis Potosí. At the present time we cannot regard these as warranting subspecific designation.

Concerning the generic designation *Oxyrhina* Jan we believe it to be in part a synonym of *Conopsis*, in part of *Toluca*. Jan apparently was not aware that Günther had already described the genus *Conopsis* or that Kennicott had described *Toluca*. The subgenus *Achirhina*, type *Achirhina de Filippii*, is apparently a synonym of *Toluca*, having apparently been separated off from *Oxyrhina* to receive a specimen having the prefrontals separated and the frontal in contact with the internasals (the condition obtaining in the type of *Toluca lineata*).

The subgenus *Exorhina*, type *Exorhina maculata* was devised for specimens having the internasals and prefrontals fused and in consequence this is a synonym of *Conopsis nasus*.

The genus *Epirhina*, type *Epirhina tessellata*, was erected for a single specimen of *O.* (*Exorhina*) *maculata* having only six supralabials. The second labial is apparently fused with the third, since it touches the nasal and preocular, and enters the orbit. The loreal is absent, and three lower labials touch the first chinshields. The color is the same as *maculata*. We have found some thirty cases where the reduction of the upper labials takes place usually on one side, but in some 6 specimens on both sides. The second labial forms part of the lower rim of the orbit in certain cases.

Specimens Examined. One hundred and seventy-five, from the following localities: Mojárachic (EHT-HMS 1), *Chihuahua;* East of Santa Cruz (AMNH 6), Cuidad de Chiquihuite (AMNH 1), *Distrito Federal;* Guanajuato (USNM 4), Maravatío (EHT-HMS 3), *Guanajuato;* 6 miles NE. Morelia (EHT-HMS 3), 10 miles E. of Morelia (USNM 1), Cojumatlán (EHT-HMS 1), 4 mi. E. of Lake Pátzcuaro (EHT-HMS 14), Tacícuaro (EHT-HMS 7, USNM 4), *Michoacán;* Alvarez (MCZ 125), *San Luis Potosí;* Plateado (USNM 1), *Zacatecas;* no locality (AMNH 2, USNM 2). Literature records for localities other than these are for Contreras, *Distrito Federal;* Milpas, *Durango;* Moro León, *Guanajuato;* La Cumbre de los Arrastrados, *Jalisco;* Tepéxpam, *México;* Tangancícuaro, *Michoacán;* and San Luis Potosí, *San Luis Potosí* (see synonymy).

Conopsis biserialis sp. nov.

(Pl. XXXI, fig. 1; XXXV fig. 9; text figs. 2, 3)

Type.—EHT-HMS No. 23648, collected 10 mi. west of Villa Victoria, México, 1940, by E. H. Taylor.

Paratypes.—EHT-HMS Nos. 4708-4719, 4721, 5091A, 5092-5101, 5101A, 5102-5108, 5300, 23635, near Tres Cumbres, Morelos; 4690, 4702, 4757-4759, 4759A, 4760-2, 5313, 15 mi. SE. of Zitácuaro, Michoacán; 4768-9, 2 mi. south of San Martín, México; 16244-16245, 21488, 23647-23648, 23696-23697, 10 mi. west Villa Victoria, México; all collected by either H. M. Smith or E. H. Taylor. Also Field Mus. Nat. Hist. Nos. 37091-37113, Tancítaro, Michoacán; and Chicago Acad Sci. No. 6983, Uruapan, Michoacán.

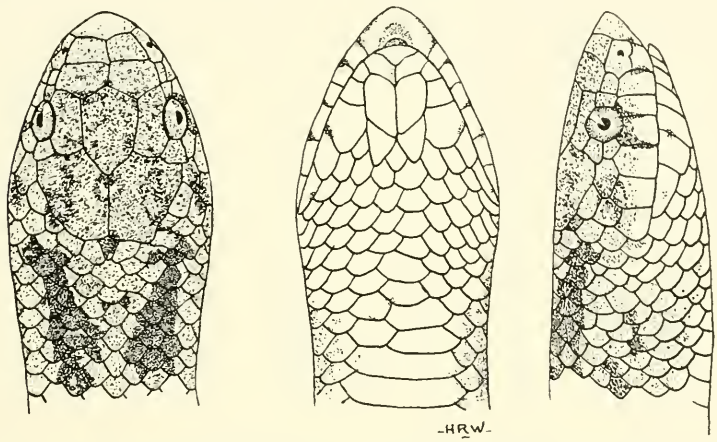


FIG. 2. *Conopsis biserialis* sp. nov. Type, EHT-HMS No. 23648, 10 miles W. Villa Victoria, México. Three views of head, ×3.

Diagnosis.—Characterized normally by the presence of paired internasals and prefrontals; a loreal; nasal single, pierced by nostril, the part posterior to the nostril wider than part anterior; and ventral-subcaudal range, 122-133 and 36-41 ♂, 128-145 and 27-34 ♀, average 126.6 and 38.6 ♂, 133 and 30.5 ♀. Ratio of tail divided by total length, average 20.1 percent ♂, 16.2 percent ♀. Maximum length (in 55 specimens), 300 mm. (2 specimens.) Back with a paired series of dorsal marks or transverse, tessellated marks.

Description of the type.—Head rather bluntly pointed, the frontal region not curving down; part of the rostral visible above about three-fourths its distance from the frontal; internasals large, much more than half the size of the prefrontals; frontal obtusely

angulate anteriorly, acutely angled posteriorly, nearly a fourth longer than its distance from the tip of the snout, and minutely shorter than the parietals; nasal much longer than high, irregularly rectangular, the part posterior to the nostril much wider than anterior part; nostril irregular in shape, small; loreal large, quadrangular, touching second labial; preocular a little higher but narrower than loreal; eye diameter one-fourth less than distance from eye to nostril, less than half the length of the snout, a fourth or more greater than its distance from mouth; two postoculars; temporals, $1 + 2 + 3$; seven upper labials; six lower labials; two pairs of chinshields, first pair much larger, second pair in contact anteriorly, but nearly separated by a single scale; scale formula, 23, 17, 17, reducing to 15 at anus; ventrals 132; anal divided; subcaudals 33; four pairs of small scales between first ventral and the last chinshields; scales smooth, at least a part showing dim apical pits.

Color.—Head ashy gray above, with a scattering of dark flecks. There are indications of a larger spot on the outer edge of the parietal, and a white spot surrounded by darker color on the parietal suture; lower part of upper labials white, save for an irregular black spot below eye. Chin and throat creamy white. Body blue-gray with paired series of dark spots which may fuse on the middle of the back, and a lateral series of smaller spots on each side; below this series the edges of certain of the scales may be strongly edged with black. There is indication of a faint median lighter line and a slightly lighter dorsolateral gray stripe between the series of dark spots. Below cream, with anterior edges of the ventrals blackish, and large scattered quadrangular or irregular spots of black; a dark median subcaudal line.

Measurements in mm.—Total length, 293; tail, 47; length of head, 12; width of head, 8.8.

Dentition and hemipenes.—The dentition of the species is as follows: Maxillary teeth, 12 or 13, small, more or less subequal; the posterior two or three teeth may be very slightly thicker, and a slight depression may be discernible on the outer posterior face, which tends to make the posterior part of the tooth sharp-edged; 8 palatine teeth; 14 pterygoid teeth, without the lateral depressions, and larger than the maxillary teeth; 15 dentary teeth, distinctly smaller than the maxillary teeth, and lacking any trace of lateral depressions.

The characters of the hemipenes (from No. 4757) is as follows: Hemipenis 9 caudals long; spines absent on the basal two caudal lengths, but present from that point to the tip; spines closely placed

near the tip and small, but increasing in size proximally; proximal spines larger and more widely spaced; sulcus single; very minute spines scattered among the larger spines, discernible at least proximally; an incomplete row of terminal calyces at the extreme tip. The spines reach the calyces, and the papillae in the calyces may have hardened points.

Variation.—A number of the characters of this species are somewhat variable. Two specimens of the 55 available for study have the prefrontals and internasals fused and save for their conformation with the other scale characters of the species, as well as the typical coloration of these, one might mistake them as belonging to *Conopsis nasus* Günther. One of the specimens is anomalous in numerous characters and is from the presumed western limit of the range. The other specimen is from the high mountains of Morelos. The presence of the loreal is the normal condition, but it may fuse with either the preocular, the second labial, or the nasal. Altogether there are eight specimens of the 55 in which the loreal has fused to an adjoining scale on both sides, and one specimen where the fusion occurs on one side only. While six is the normal number of lower labials a few specimens have but five. In these cases, it is usually the second and third that fuse. This fusion occurs in 14 out of 110 cases, sometimes on one side, sometimes on both sides.

A few other specimens show anomalies; one has the anterior temporal fused to the sixth labial, one has two anterior temporals, and two have a single secondary temporal. One specimen has the two postoculars fused.

With regard to variation in the ventral-subcaudal counts, there is an expectation of a variation in ventrals of about ten scales in each sex. The ventrals of males in this species vary from 122 to 133, which is a range of 12, but only one specimen has more than 130. In the females the range is 128 to 145, a range of 18. However, the bulk of the specimens are between 128 and 135, as only three are higher: one 138, one 140, and one 145. These specimens appear to be normal in every way otherwise. The total range for this species, 122-145, is a range of 24 scales. The subcaudal ranges are six in males, and eight in females.

The variation in color and to some extent in pattern is confusing. The ground color varies between a gray or bluish gray, and a reddish faun. These two types of coloration are not confined to age or sex groups, nor has it to do with the habitat, since both types are found together throughout the range. The markings likewise vary. The

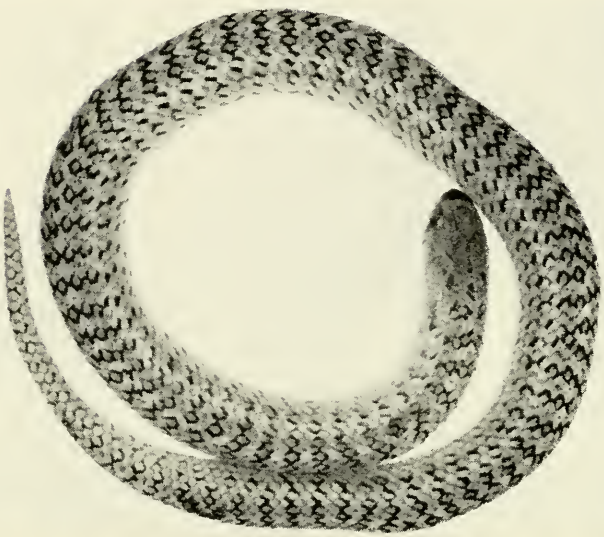


FIG. 3. *Conopsis biserialis* sp. nov. Paratype, EHT-HMS No. 4720 (light phase), Tres Cumbres, Morelos (enlarged).

darker phase usually has the paired spots along the back separated by a line, often scarcely visible, slightly lighter in color than the ground color; dorsolaterally there is a very dim grayish stripe occupying one and one-half scale rows (the fifth and part of the sixth rows); on the fourth row there is indication of a series of small, irregular spots or markings. On the ventral surface the pigment may border the anterior edges of the ventrals or be arranged as occasional spots on the posterior edges of the ventrals. Often the ventral pigmentation increases so that the venter may appear almost solid black, save for a continuous light streak on the edges of the ventrals. The chin is usually cream with some occasional dark flecks. In other specimens the ventral pigmentation may be entirely wanting or reduced to a few tiny dark flecks.

In the lighter phase there is a tendency for the dark markings to form tessellated bands across the back, which are not or only partially interrupted on the middle of the back; the dorsolateral stripe is not or only faintly indicated; the venters are usually rosy or cream and the pigmentation may be entirely wanting. The transverse bands are not solid, but only the scale edges are outlined in black. There is an average of about 60 paired spots or transverse bands on

body, about half as many as there are ventral scales. They tend to disappear on the tails.

Genus Toluca Kennicott

The original description of the genus *Toluca* follows: "Genus Toluca, Kennicott.—Size small. Body very stout, sub-cylindrical, deeper than wide. Tail short and thick. Head short and broad, wedge-shaped, almost continuous with the body. Snout pointed and projecting. Cephalic plates normal. Vertical large, sub-hexagonal, the elongated anterior angle separating the post-frontals. Occipitals shorter than vertical. Rostral turned back upon the crown, and occupying the entire point of nose. A single elongated nasal; no loral. Dorsal scales smooth. Post-abdominal scutella divided; subcaudal all divided."

Toluca lineata Kennicott

"Sp. Ch.—Body exceedingly stout. Tail about one-sixth of the total length. Head short, wedge-shaped, scarcely wider than the neck. Snout much depressed, acutely pointed, and projecting beyond the lower jaw. Crown arched throughout. Vertical plate very large, sub-hexagonal, the anterior extremity elongated in a narrow process to the anterior frontals, thus widely separating the post-frontals. Occipitals nearly as broad as long. Superciliaries small. Rostral proportionally large, the apex obtusely pointed, and its centre forming the acute point of the nose. Nasal pentagonal, much elongated, pointed posteriorly. One small sub-pentagonal ante-orbital, as long as high; two post-orbitals, upper slightly largest; seven upper labials, first much smaller than the second and succeeding ones; lower labials, six. Dorsal scales in 17 rows. The scales of the first lateral rows are higher than long; those of the central rows narrower; the outer row largest. Color above uniform light brownish ash, with three imperfect longitudinal blackish stripes, each on a single row of scales.

"The vertebral stripe the most distinct; the lateral stripes obsolete on the fourth lateral row on each side. The stripes are formed by scales with the bases black and the tips of the ashy ground color; the scales involved by the vertebral stripe have their tips even lighter than the ground color. Each dorsal scale appears, on close examination, to be minutely mottled with blackish, and when the skin is stretched the covered base of each scale is seen to be black. Head brownish ash, minutely mottled with blackish; labials lighter. Abdomen uniform greyish white.—(Kennicott.)"

KEY TO SPECIES OF TOLUCA

A. Internasals absent.
  B. Snout bluntly conical; three posterior maxillary teeth somewhat enlarged with a shallow groove. Oaxaca and Guerrero.....*Toluca conica* sp. nov.
  BB. Snout rather sharply pointed; posterior maxillary teeth very greatly enlarged, with a deep groove the length of tooth. Cerro San Felipe, Oaxaca.....*Toluca megalodon* sp. nov.

AA. Internasals present.
  B. Body with three or five more or less distinct lines; ventrals 114 to 126 in males, average 119 (80.3% less than 122), 118 to 132 in females, average 126 (85.6% less than 129); the second supralabial usually in contact with preocular (88.4%); belly spotted or stippled (immaculate in reddish phase); six or seven lower labials. The southern part of the plateau from Jalisco to Veracruz, avoiding the deserts of southern Puebla and the mountains of adjacent central Veracruz.....*Toluca lineata lineata* Kennicott.
  BB. Body with spots or transverse marks, or tessellated.
    C. General pattern tending toward narrow, irregular markings, rarely lacking any distinct markings, or with a tessellated pattern. Ventrals 119 to 130 in males, average 124 (16.2% less than 129), 122 to 141 in females, average 132 (12.9% less than 129); usually the second upper labial is separated from the preocular on one or both sides (73%). Belly never spotted or stippled. Western Veracruz and eastern Puebla.....*Toluca lineata varians* Jan.
    CC. General pattern usually forming spots transversely elongate covering several scales; head usually black or with a black mark; ventrals 111-124 in males, 119-131 in females; belly and tail or at least tail spotted or pigmented. Puebla, eastern Veracruz and Oaxaca.....*Toluca lineata acuta* Cope.

Toluca megalodon sp. nov.

(Pl. XXX, fig. 1; pl. XXXV, fig. 1; text fig. 4)

Type.—EHT-HMS No. 23640, collected at the summit of Cerro San Felipe, Oaxaca, Oaxaca, by Edward H. Taylor.

Diagnosis.—Posterior teeth very greatly enlarged, with a conspicuous deep groove; no internasals; loreal variable, present or absent (fused to nasal); five or six lower labials; body faun color, with a median series of dimly outlined spots; venter immaculate cream.

Description of the type.—Head distinctly pointed; portion of the rostral visible above only a little shorter than its distance from the frontal; internasal absent; prefrontals large, their greatest length greater than their width; frontal obtusely angulate anteriorly, and acutely angled posteriorly, its length at least a fourth greater than its distance from the tip of the snout, and minutely longer than the parietals. Nasal elongate, single, the nostril large, somewhat triangular, pierced nearer the anterior end of the scale; on the right side the nasal is in contact with the large preocular, the loreal absent, while on the left side a small loreal is present separating the nasal from the preocular; diameter of eye less than its distance from the nostril; two postoculars; one anterior, two posterior temporals;

seven upper labials, the third and fourth bordering orbit; lower labials, five (right) and six (left), three or four touching the anterior enlarged chinshields; second pair of chinshields small, in contact.

Scales smooth, with a single, indistinct, apical pit; scale formula 21, 17, 17, 17; ventrals 131; anal divided; subcaudals divided, 29.

Twelve maxillary teeth, the tenth and eleventh very greatly enlarged, and very deeply grooved from tip to base (the posterior tooth missing); 9 palatine teeth; 13 pterygoid teeth, somewhat grooved on

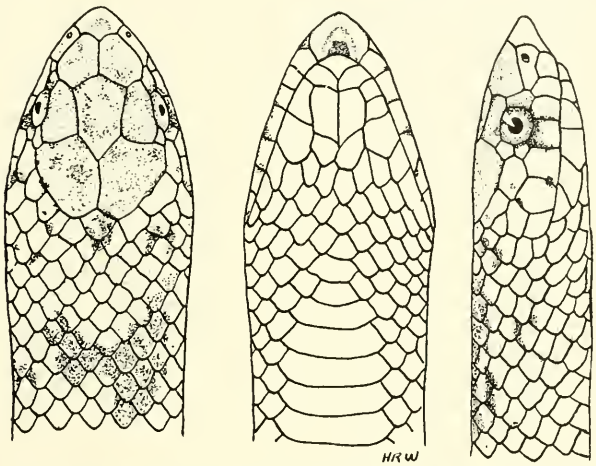


FIG. 4. *Toluca megalodon* sp. nov. Type, EHT-HMS No. 23640, Cerro San Felipe, Oaxaca, Oaxaca. Three views of head, × 3.

their inner surface; 15 dentary teeth, grooved on their outer surfaces.

Color.—In life reddish amber-olive generally; with epidermis removed, faun above, with about 48 more or less distinct dark markings on the back; an indistinct lateral light stripe on the fifth scale row; indistinct black flecks on scales of the third and fourth rows; ventral surface immaculate cream. Head with markings very indistinct, the frontal very slightly darker than other head scales.

Measurements in mm.—Total length, 251; tail, 37; tail percent of total length, 14.7; head width, 7; head length, 12.

Remarks.—The single type specimen was captured in the afternoon crawling on open ground, at an elevation of about 10,000 feet, on Cerro San Felipe. Its behavior, when approached, was unusual. It remained quiet for a time, then spread its head and body somewhat in the manner of *Heterodon nasicus*. This behavior has been observed once in *T. lineata varians*, near Acultzingo.

Other species of both *Conopsis* and *Toluca* are presumably nocturnal in habits, for the most part, since very few of the several hundred specimens we have taken have been found in the open. In fact, the only occasion, aside from the one mentioned, was in the morning on a moderately cool, cloudy day, on the lava beds near El Limón (Totalco), Veracruz, where several *T. lineata lineata* were found moving about on grassy spots near rocks.

Toluca conica sp. nov.

(Pl. XXXIV, fig. 1; text fig. 5)

Type.—EHT-HMS, No. 27517 ♂ ; collected at San Juan Guivini, Oaxaca, by Mr. Thomas MacDougall, January, 1941.

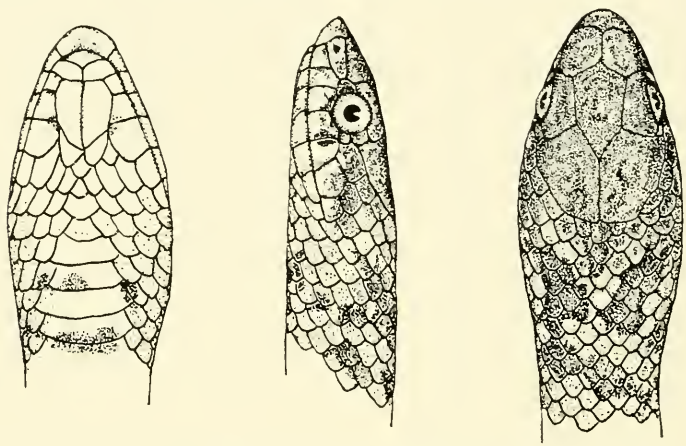


FIG. 5. *Toluca conica* sp. nov. Type, EHT-HMS No. 27517, San Juan Guivini, Oaxaca. Three views of head, × 3.

Paratypes.—United States National Museum No. 46535, Guajamaloya, Oaxaca; University of Michigan Museum of Zoölogy, Nos. 85703-85710, vicinity of Chilpancingo, Guerrero; Museum of Comparative Zoölogy Nos. 42651-42654, Omilteme, Guerrero; EHT-HMS Nos. 23638, 23639, Omilteme, Guerrero; Field Mus. Nat. Hist. No. 38397, Chilpancingo, Guerrero.

Diagnosis.—Internasals normally wanting (fused with the prefrontals); loreal normally fused with the nasal, which contacts the preocular, or if present, very minute; six lower labials; posterior teeth enlarged and grooved. Usually heavily pigmented below and with small punctate black spots on the ventrals. Three dorsal series of dark spots, the median largest.

Description of the type.—Head rather short, somewhat conical, especially when seen in profile; the length of the part of rostral visible above equal to about four-fifths its distance from frontal; prefrontals large, their greatest width greater than their length; frontal obtusely angulate anteriorly and acutely angulate posteriorly, its length nearly two-thirds greater than its distance from the tip of the snout, and practically the same length as the parietals. Diameter of eye equal to its distance from the nostril, and equal to length of nasal scale; latter more than twice as long as high; preocular subtriangular, large; two postoculars, both touching the anterior temporal, which is about one-fourth longer than high; two smaller secondary temporals; seven upper labials, the second broadly touching the preocular, the third and fourth forming the lower border of the orbit; six lower labials, four of which touch the very large anterior chinshields; second pair of chinshields small, in contact with each other. Scale formula, 23, 17, 17, 17; ventrals 126; anal divided; subcaudals 38, all divided; about three pairs of scales between the second chinshields and the first widened ventral.

Color.—The dorsal surface, including the sides, are grayish lavender. Head nearly uniformly flecked with blackish on a light background, which is minutely peppered with brownish pigment visible only under magnification; a pair of diagonal marks tend to form a V on the neck; a median series of 50 transverse spots or marks, the anterior ones more distinct; a similar number of small lateral spots; lips cream, with a dark mark below the eye. The ventral surface nearly uniformly pigmented and with numerous small blackish lavender spots which tend to alternate on the ventrals. The underside of the tail with thirteen, median, lavender spots.

Measurements in mm.—Total length, 267; tail, 50; length of head, 10.5; width of head, 7; the tail is 18.7 percent of the total length.

Variation.—The specimens from Chilpancingo and Omilteme are reasonably uniform in their general habitus but differ somewhat in details of squamation and color markings.

The fused condition of the prefrontals and internasals is the normal one. However, one exception, UMMZ No. 85704, has the internasals separate. There are lateral invasions of sutures in the prefrontals of UMMZ No. 85705 and MCZ No. 42651; UMMZ No. 85705 has the right prefrontal divided while the left is single.

The relationship of the nasal, loreal and preocular varies somewhat. The loreal is normally absent, that is, fused to the nasal, which is consequently much elongated and in contact with the rather

large preocular. However, three specimens have a tiny loreal separating the nasal and preocular. In two specimens the prefrontal and labial are in contact. In these, the greater elevation of the second labial suggests that here the fusion of the loreal is with the second labial. The ground color of most of the specimens is varied blackish, gray, and brown, or varying shades of gray where the epidermis has been removed. There is a pattern of spots, arranged in three rows, the anterior spots often edged with white. The median series begins on the neck with a large U-shaped mark which does not quite reach the parietals, and continues to end of tail, the spots diminishing in size. In some specimens the spots are small, more or less confined to one scale and the edges of adjoining scales. In others they are larger, covering as many as six scales and edges of adjoining scales at least on the anterior part of the body.

On each side of the median series there is usually a distinguishable row of spots or flecks covering one scale or parts of several. These outer spots correspond to those of the median row and are occasionally continuous, thus forming a pattern of a single row of irregularly shaped, narrow, transversely widened spots. Occasionally the spots are so reduced that a somewhat tessellated pattern results at least on the posterior part of the body.

The ventral surface is more or less heavily pigmented, especially toward the outer part of the ventrals. Besides this there may be an elongate dark mark across the anterior edges of the ventrals, or the spots may be quadrangular and placed on alternate ventrals; sometimes there are two or three small marks on each ventral, while the remainder of the scale is lacking pigment. In some the ventral surface is heavily suffused with grayish or brownish, almost obscuring the darker maculations. The chin and underside of the neck is light, save that a few specimens have the lower labials edged with black. Others have only one or two spots on the lower labials.

The lot of material from Oaxaca is very unsatisfactory as regards quantity. It consists of two specimens from known localities, USNM No. 46535 from Guajamaloya (20-25 miles east of Oaxaca, 9,500 ft.), and EHT-HMS 27517 from San Juan Guivini. Aside from those there are four USNM specimens (Nos. 31361, 31363, 31365) from unknown localities, collected by Adolphe Boucard. We believe this material to have been collected in Oaxaca.*

* Adolphe Boucard and Auguste Salle were collecting in México prior to 1858 (in 1855, *fide* Kellogg, USNM Bull. 160, p. 12), in Veracruz, Puebla and Oaxaca, since herpetological specimens are credited to Boucard from the two latter states (Bocourt, Miss. Sci. Mex. pp. 363 and 566).

Variation in ventral and subcaudal scale counts of *Toluca conica* sp. nov.

Locality	Sex	Number specimens	Ventrals	Subcaudals	Average	Tail, percent total length
Guerrero	♂	9	111-125	27-36	121-32.4	17.1
Guerrero	♀	14	127-134	23-30	129-25.4	13.9
Oaxaca†	♂	2	123-129	35-36	126-35.5	16.5
Oaxaca	♀	4	126-131	29-30	128.5-29.5	14.4

Toluca lineata lineata Kennicott

(Plate XXXIV, figs. 2, 4, 5; XXXV, figs 3, 7, 8; text fig. 6)

Stenorrhina De Filippii Jan, Ind. Sist. Rett. Anf. Milano, 1857, p. 48 ("Messico"; *nomen nudem*).

Toluca lineata Kennicott, in Baird, Rep. U. S. Mex. Bound. Survey, 1858, pp. 23-24, pl. 21, fig. 2 (type description; type locality, Valley of Mexico); Baird, Expl. Surv. R. R. Route from Miss. R. to Pacific Ocean, 10, 1859, p. 16, pl. 35, fig. 8a-8c; Cope, Proc. Acad. Nat. Sci. Phila., 12, June 26, 1860, p. 241 (Toluca Valley); Garman, Bull. Essex Inst., 16, 1884, p. 30; Cope, Proc. Amer. Philos. Soc., 22, 1885, p. 387 (Xochimilco); Bocourt, Bull. Soc. Zoöl. France, 17, 1892, p. 41 (reports a specimen in the oviduct of a *Conopsis lineatus* such as the one figured by Kennicott as *Toluca lineata*); Günther, Biologia Centrali-Americana, Rept. Batr., May 1893, p. 95; Gadow, Proc. Zoöl. Soc. London, 1895, p. 233 (Toluca, 8600 '); Cope, Amer. Nat., 30, 1896, p. 1021 (distribution); and Rep. U. S. Nat. Mus., 1898 (1900), pp. 946-947.

Oxyrhina (*Achirhina*) *De Filippii* Jan, Arch. Zoöl. Anat. Fis., 2, fasc. 1, 1862, pp. 54, 61, 75 (type description; type locality "Messico").

Oxyrhina de Filippii Jan, Elenco Sist. Ofid., 1863, p. 41; J. W. Müller, Reisen Ver. Staat. Canada, Mexico, 1865, p. 606.

Ficimia lineata Garman, Mem. Mus. Comp. Zoöl., 8, 1883, pp. 161-162.

Conopsis lineatus Bocourt, Miss. Sci. Mex. Amér. Cent., étude Rept., Livr. 9, 1883, pp. 565-566, pl. 35, fig. 4 (Puebla); Bocourt, Bull. Soc. Zoöl. France, 17, 1890, p. 41.

Conopsis lineata Dugès, Mem. Soc. Cient. Antonio Alzate, 9, 1896, p. 413 pl. 5 (*part.*); and Bull. Mus. Hist. Nat. Paris, 7, 1896, 319-323 (*part.*).

Achirhina de Filippii Dugès, La Nat., Ser. 2, 2, 1896, p. 481.

Conopsis nasus Smith, Zoöl. Ser. Field Mus. Nat. Hist., 24, No. 4, Jan. 30, 1939, p. 32 (Chalco, México, and Orizaba, Ver.; *part.*; the Orizaba specimen is *lineata varians*).

Toluca lineata Kennicott was the first species of this genus to be described and is consequently the genotype. The type specimen is anomalous in the character of the anterior head scales. The prefrontals are reduced in size and a forward projection of the frontal separates them and is in contact with the internasals. Cope, in the "Crocodilians, Lizards and Snakes," has retained the genus and species primarily on the basis of the anomaly, commenting that he does not regard it an anomaly. Save for this fact it seems likely that he would have discarded the genus *Ogmius* for the species having the enlarged posterior maxillary teeth, and used Kennicott's generic name.

Our reason for believing that the condition is anomalous is that occurring in the region where these specimens are found are other specimens having all of the characteristics save that of the separated prefrontals, and these considerably outnumber the others. Thus

† Includes the presumed Oaxaca specimens of the USNM collected by Boucard.

we have found the condition present in four specimens out of twenty males, and in five out of thirteen females. Thus the percentage of occurrence is about 27 percent. The same anomaly has been observed once in a specimen of *Conopsis nasus*. It may occur in other forms of *Toluca*. We do not regard the condition as taxonomically significant.

Throughout most of the range the color pattern remains constant. However, there are certain scale characters that are variable, particularly the condition of the loreal and the number of the lower labials. The ground color of the species is a dark olive or brown

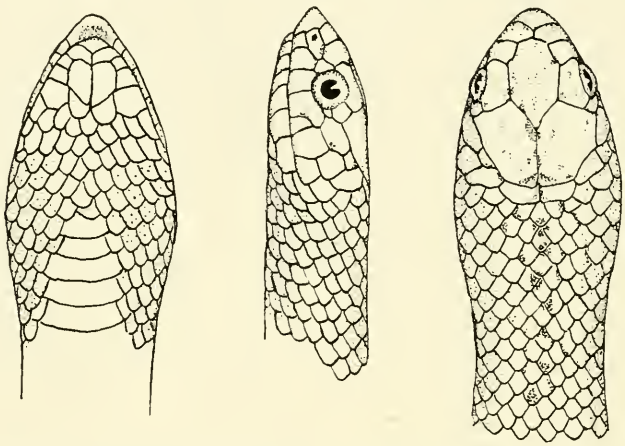


FIG. 6. *Toluca lineata lineata* Kennicott. Paratype, USNM No. 2104, Valley of México. Three views of head, × 3.

olive. Usually five darker lines are visible. These are a median line, usually the most distinct, a lateral line, often nearly obsolete, and between these two an indistinct dorsolateral line. When the epidermis is removed the lines appear to be rows of small dots or flecks rather than continuous lines. The space between the two outer is usually lighter in color than the remaining ground color, and when the epidermis is removed takes on the appearance of a grayish stripe. Most specimens have small spots on the ventrals.

Throughout the range occasional specimens are reddish or pinkish in color. In these the dark lines are very dim, and occasionally the lateral and dorsolateral lines are obsolete. The pigmentation of the venter and the black spots are missing. In these the apical pit is usually very distinct, if the epidermis has not been removed.

The reduction of the number of lower labials takes place much

more frequently in the eastern and northeastern part of the range. In a group of sixteen specimens from the region near Lake Pátzcuaro, all were provided with seven lower labials; the loreal was present in 12 cases in 32; normally the loreal touches the preocular, but in three cases in 32, the second labial was in contact with the prefrontal. In a series of 6 specimens from Hidalgo, the loreal is present in 6 out of 12 times. Seven lower labials occur 11 times out of 12.

In the extreme northeastern part of the range the reduction in the labials occurs the greatest number of times. In a series of 72 specimens from Tezuitlán, Puebla, there are seven lower labials 47 times in 144; the loreal is present 65 times in 144. In a series of 40 specimens from Totalco, Puebla, about 20 miles south of Tezuitlán, there are seven lower labials 42 times out of 80, and the loreal is present 43 times in 80. At Cruz Blanca and the region near Las Vigas the loreal was present 44 times in 68 and seven labials occurred 41 times in 68.

The variation in the ventral counts is 114-126 (average 119.2) in males, and 118-132 (average 125.9) in females. The subcaudals are 33-45 in males (average 38.5), while in females the range is 23-33 (average 28.8).

The subcaudals are normally divided in this species but 65 specimens in 257 examined for this character showed undivided scales. These range from 1 to 23, but the average number is two or three.

The length of the tail varies somewhat with age and sex. The average percent of tail to total length in males is 19.8 (132 specimens) and in females 15.1 (116 specimens).

The hemipenes are typical of the genus. The calyces cover a small area, about two or three rows, less than one caudal scale in length. The maxillary teeth are usually 12 or 11, the last three enlarged and distinctly grooved on the outer side; palatine teeth 7 or 8; pterygoid teeth 12 to 14 (rarely less); 14 or 15 dentary teeth. Many of the teeth show a slight depression on the side.

Specimens examined.—Two hundred and fifty-eight, from the following localities: Cruz Manca (AMNH 1), México (City) (MCZ 6, UMMZ 1), San Juan Teotihuacán (AMNH 3, MCZ 1), east of Santa Cruz (AMNH 3), 1½ mi. E. of Santa Lucia (AMNH 8), *Distrito Federal;* San Felipe (EHT-HMS 2), 3 miles N. E. of Santa Rosa (EHT-HMS 1), *Guanajuato* (USNM 1); Guerrero (MCZ 49, EHT-HMS 1), Minas Viejas (EHT-HMS 5), San Miguel (MCZ 2, UMMZ 1), Tianguistengo (EHT-HMS 2), Tulancingo (USNM 1),

Velasco (MCZ 5, UMMZ 1), *Hidalgo;* Chalco (FMNH 2), Mt. Popocatépetl (MCZ 7), Toluca (EHT-HMS 4), 15 kilometers W. of Toluca (USNM 5, EHT-HMS 4), *México;* Nahuatzín (USNM 1), 4 miles E. of Lake Pátzcuaro (EHT-HMS 15), 5 miles S. of Carapa (EHT-HMS 9), between Zacapú and Zamora (EHT-HMS 4), *Michoacán;* Zempoala (EHT-HMS 3), *Morelos;* Río Frío (UMMZ 6), Puebla (USNM 1), Tezuitlán (EHT-HMS 3), *Puebla;* Mts. near Jesus María (USNM 1), *San Luis Potosí;* Cruz Blanca (EHT-HMS 18), El Limón (Totalco) (EHT-HMS 35), Las Vigas (EHT-HMS 1, USNM 2), Pan de Olla (UMMZ 13, USNM 18), Tequeyutepec (EHT-HMS 1), Toxtlacuaya (EHT-HMS 2), *Veracruz;* no locality (AMNH 5, UMMZ 1, USNM 3).

Toluca lineata acuta (Cope)

(Plate XXXIII, figs. 1-6; text fig. 7)

O[gmius] acutus Cope, in Ferrari-Perez, Proc. U. S. Nat. Mus., 9, 1886, p. 189 (type description; type locality, "Tuchitan on the Pacific side of the isthmus of Tehuantepec," probably in error).

Ogmius acutus Cope, Bull. U. S. Nat. Mus., No. 32, 1887, p. 82 (W. Tehuantepec); Boulenger, Cat. Snakes British Museum, 2d Ed., III, 1896, p. 229 (W. Tehuantepec); Werner, Arch. Naturg., 79 (A 12), 1924, p. 148.

Ogmius varians Cope (non Jan) Proc. Amer. Phil. Soc., 1869, p. 162.

Chionactis diasii acutus Cope, Rep. U. S. Nat. Mus., 1898 (1900), p. 943 ("Juchitan," Tehuantepec).

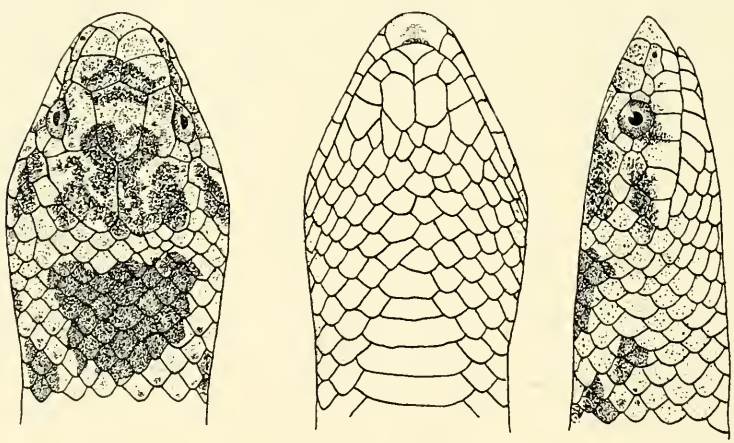


FIG. 7. *Toluca lineata acuta* (Cope). EHT-HMS No. 16190, near Cacaloapan, Puebla. Three views of head, × 3.

This form may be characterized as differing from *lineatus* in having a median series of transverse spots often only narrowly separated from the lateral series.

The tails are longer, averaging more than 21 percent of the total length in adult males, the loreal is present, seven lower labials; some pigmentation on ventral surface (sometimes confined to tails). The ventral range is from 123-131 in females; 111-123 in males; the subcaudal counts vary from 25 to 35 in females, 35 to 42 in males.

Variation.—The variation in ratio of tail length to body length is largely a matter of age, the tail being proportionally shorter in young specimens. The average percent in males is 20.8 (39 specimens) and 16.3 (25 specimens) in females.

The teeth include 12 maxillary, the last three enlarged and deeply grooved; 8 or 9 palatine teeth; 12 or 13 pterygoid teeth and 15 dentary.

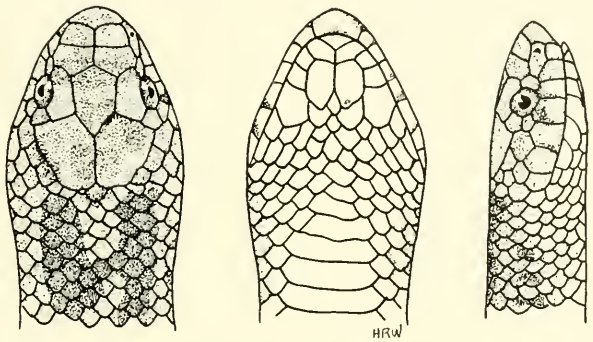


FIG. 8. *Toluca sp.?* EHT-HMS No. 23641, foot of Cerro San Felipe, Oaxaca, Oaxaca. Three views of head, × 3.

The hemipenes (EHT-HMS No. 5316) have extremely small areas of papillate calyces at the tip. The spines merge gradually from the small ones near the calyces to the large ones near the base; basal part (2½ caudal lengths) spineless.

This form seems to be an inhabitant of the upper Balsan faunal district. There is evidence of intergrading in the northern part of Puebla with *Toluca lineata lineata.*

Specimens examined: Sixty-four, all with definite locality, from the state of Puebla. Localities represented are Cacaloapan (USNM 2, UMMZ 1, EHT-HMS 13), Laguna San Bernardino, nr. Miahuatlan (EHT-HMS 2), Tepeyahualco (EHT-HMS 35), and El Seco (UMMZ 25). Specimens from doubtful localities are the type, USNM 30552, said to be from Juchitan, Oaxaca, but probably not; and five specimens, UMMZ 88698, said to be from El Limón (Totalco), Veracruz, but which do not agree with some 35 others

from that locality, and do agree with more southern specimens from the vicinity of Tehuacán.

A single specimen which one of us (Taylor) collected at the foot of Cerro San Felipe near the village of San Felipe, has not been referred to any of the listed species. We are unable to say whether the presence of the internasals is the normal condition or not. More specimens from this critical region will be necessary before this matter can be determined. It may represent an undescribed form. Figures of the head and maxilla are given. (See Plate XXXV, fig 6; and text fig. 8.)

Toluca lineata varians (Jan)

(Plate XXXI, figs. 2, 3; plate XXXII, fig. 1; plate XXXIV, fig. 3; plate XXXV, fig. 2; text figs. 9, 10)

Stenorrhina varians Jan, Ind. Sist. Rett. Anf. Milano (Cenni sul Museo Civico de Milano), 1857, p. 48 (*nomen nudem*).

Oxyrhina varians Jan, Arch. Zoöl., 2, fasc. 1, 1862, pp. 54, 60, 61, 75 (type description; type locality, "Messico"); and Elenco Sist. Ofid., 1863, p. 41; ?Dugès, La Nat., I, 1869, p. 144 (*Oxyrrhina;* "Guanajuato"; locality probably erroneous or the specimen wrongly identified; perhaps this is *T. lineata*); J. W. Müller, Reisen Ver. Staat. Canada Mexico, 1865, p. 606; and Verh. Naturf. Ges. Basel, 7, 1884, p. 285 (Orizaba [Mt.?]).

Ogmius varians Sumichrast, Arch. Sci. Phys. Nat., 46, 1873, p. 249 (cold regions, 2250 meters); Cope, Proc. Amer. Philos. Soc., 18, 1879, p. 265 (Guanajuato, Mexico Plateau; the Guanajuato reference is probably incorrect); and Proc. U. S. Nat. Mus., 9, 1886, p. 189; and Bull. U. S. Nat. Mus., 32, 1887, p. 82.

Ogmius (*Oxyrhina*) *varians* Sumichrast, La Nat., 6, 1882, p. 42 (*part.*).

Conopsis varians Bocourt, Miss. Sci. Mex. Amér. Cent., étude Rept., Livr. 9, 1883, p. 566, pl. 35, fig. 5; Dugès, Elem. Zoöl., 1884, p. 336; and La Nat., Ser. 2, I, 1888, pp. 123-124, pl. 12, fig. 10 (Valle de Mexico, Guanajuato, *lineatus*); and Mem. Gob. Guanajuato, 1895 (listed from Guanajuato, probably erroneously); and Bull. Mus. Hist. Nat. Paris, 7, 1896, pp. 319-323; and La Nat., Ser. 2, 1896, p. 481 (Texcoco, Guanajuato, México; probably confused with *lineatus*); and Mem. Soc. Cient. Antonio Alzate, 9, 1896, p. 413, pl. 5 (synono-

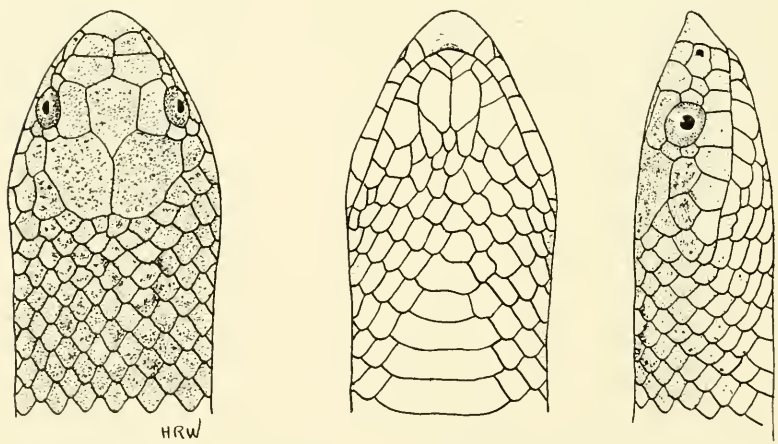


FIG. 9. *Toluca lineata varians* (Jan). EHT-HMS No. 4748, Acultzingo, Veracruz. Three views of head, × 3.

mizes *Chionactis diazii* [sic.] Cope and *Conopsis lineatus* Bocourt); Taylor and Knobloch, Proc. Biol. Soc. Wash., 53, 1940, p. 128 (*part.;* included *lineatus*).

Chionactis varians Cope, Amer. Nat., 30, 1896, p. 1021 (distribution); and Rep. U. S. Nat. Mus., 1898 (1900), p. 944.

Chionactis diasii Cope, in Ferrari-Perez, Proc. U. S. Nat. Mus., 9, 1886, pp. 188-189 (type description; type locality, Puebla, Puebla); and Bull. U. S. Nat. Mus. No. 32, 1887, p. 82 (Puebla); and Proc. U. S. Nat. Mus., 14, 1891, p. 605.

Chionactis diasii diasii Cope, Rep. U. S. Nat. Mus. 1898 (1900), p. 943.

Conopsis nasus Ruthven, Rep. Mich. Acad. Sci., 14, 1912, p. 231 (Orizaba, Ver.); Smith, Zoöl. Ser. Field Mus. Nat. Hist., 24, 1939, p. 32 (*part.*) the Orizaba specimen).

This form may be characterized as being somewhat larger than *lineata lineata,* usually lacking the typical 3 or 5 lined pattern; the tail of adult specimens averages 20 percent or more of the total length; loreal rather large and invariably present; ventrals ranging in males from 119-130, in females 128-141; subcaudals 36-45 in males, in females 29-36. Ventral scales lacking pigment or spots.

Variation.—The average percentage of the tail in total length for all females is 15.8 (106 specimens) and 19.8 in males (109 specimens).

A few specimens were found having the subcaudals undivided. In females six specimens have from one to three; in males 13 specimens show from 1 to 16. Only two of these have more than three; one seven, and one sixteen.

The maxillary teeth number from 11-13, twelve apparently being the normal number. The last three (4) are deeply grooved and considerably enlarged. The other teeth are 6 to 8 palatine, 12 to 14 pterygoid, 13 or 14 dentary. Many of these teeth show grooves or depressions on one lateral face.

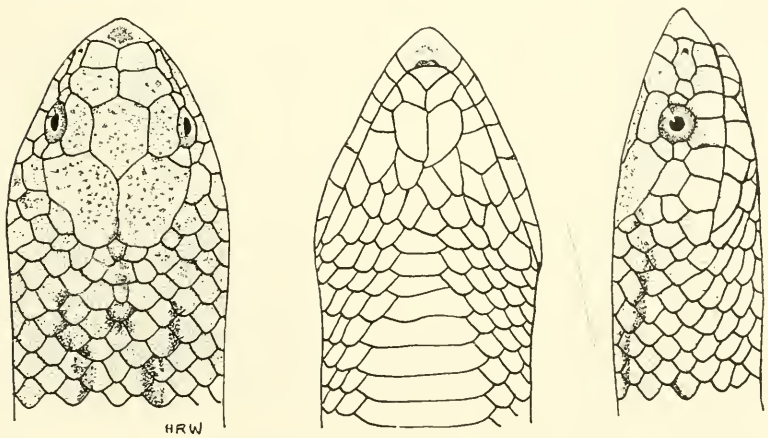


FIG. 10. *Toluca lineata varians* (Jan). EHT-HMS No. 23637, Cacaloapan, Veracruz. Three views of head, × 3.

The hemipenes (EHT-HMS 16207) have a very small distal area of papillate calyces, grading into small spines which gradually increase in size towards the base of the hemipenes. They are of the length of 11 caudal scales, the basal part (2 caudal lengths) spineless.

A series of specimens from the region near Tehuacán appear to be intergrades (at least we so interpret them) between *lineata varians, lineata lineata,* and *lineata acuta.* These vary in color and markings, the typical *lineata* marking frequently appearing. All lack ventral marking or pigmentation, and the loreal is invariably present.

Specimens examined.—Two hundred and thirteen: Acultzingo and vicinity (UMMZ 38, USNM 62, EHT-HMS 90), Orizaba and vicinity (USNM 2), *Veracruz;* Pájaro Verde (USNM 1), and vicinity of San Vicente (UMMZ 20), *Puebla.* The last series contains intergrades between *l. varians* and *l. acutus,* but most specimens are nearest *l. varians;* and certain groups of specimens from near Acultzingo are intergrades between *l. varians* and *l. lineatus.*

FIG. 11. Map showing distribution of the species of the genus *Conopsis* Günther.

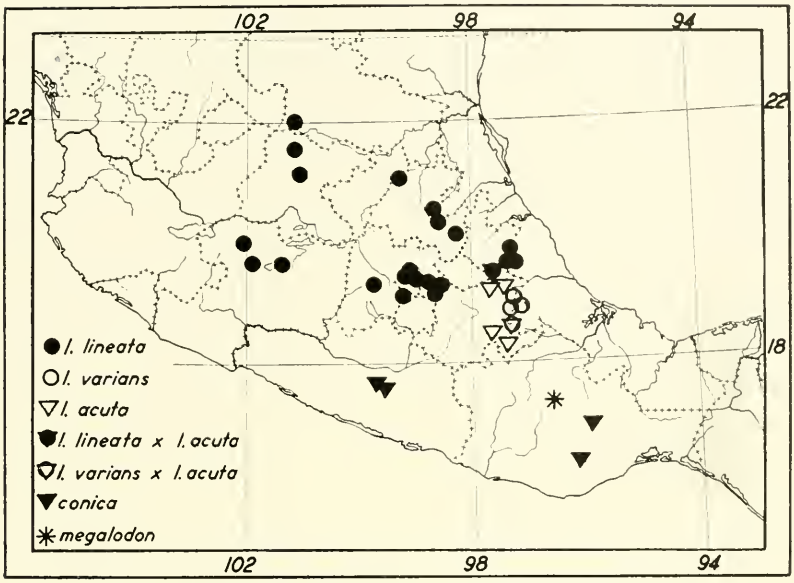


FIG. 12. Map showing distribution of the species of the genus *Toluca* Kennicott.

Plate XXX

FIG. 1. *Toluca megalodon* sp. nov. Type, EHT-HMS No. 23640 ♀, Cerro San Felipe, Oaxaca, Oaxaca.

FIG. 2. *Conopsis nasus* Günther. EHT-HMS No. 16181, about 8 Km. northeast of Morelia, Michoacán.

FIG. 3. *Conopsis nasus* Günther. EHT-HMS No. 21415, 5 miles east of Lake Pátzcuaro, Michoacán.

Plate XXX

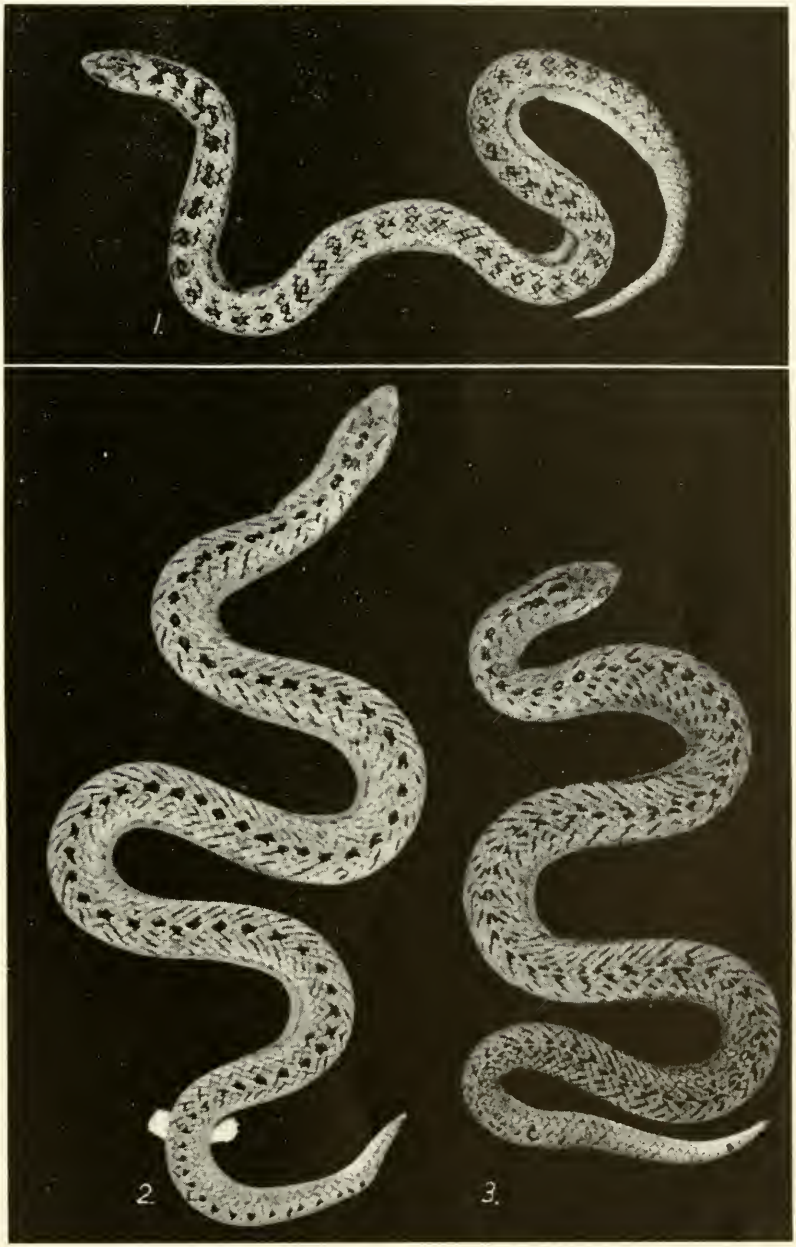


Plate XXXI

FIG. 1. *Conopsis biserialis* sp. nov. Type, EHT-HMS No. 23648, 10 miles west of Villa Victoria, México.

FIG. 2. *Toluca lineata varians* (Jan). EHT-HMS No. 16213, Acultzingo, Veracruz.

FIG. 3. *Toluca lineata varians* (Jan). EHT-HMS No. 21463, Acultzingo, Veracruz.

Plate XXXI

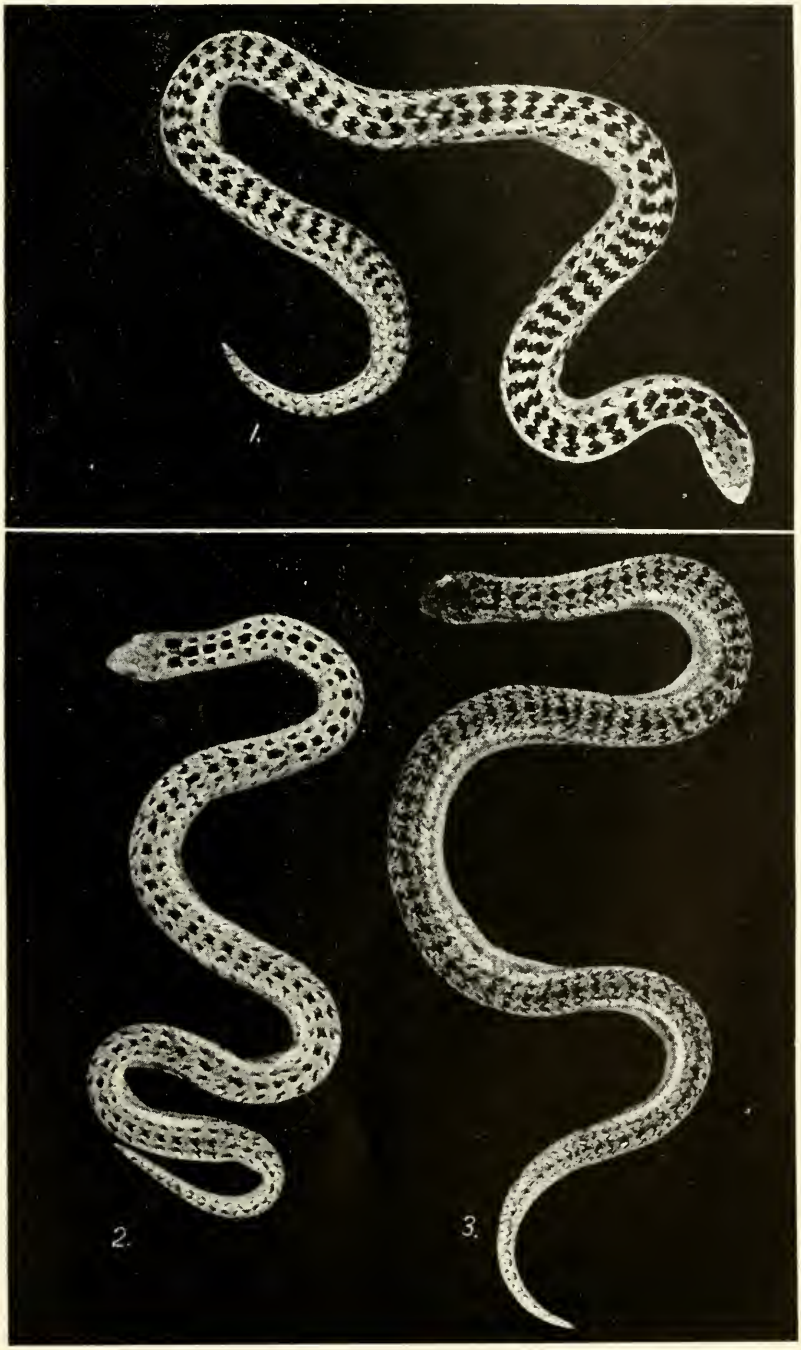


Plate XXXII

FIG. 1. *?Conopsis lineata varians* (Jan). EHT-HMS No. 23637, near Cacaloapan, Puebla (perhaps separable from *varians*).

FIG. 2. *Conopsis nasus* Günther. USNM No. 25362, probably Guanajuato, Guanajuato (Dugès specimen).

FIG. 3. *Conopsis nasus* Günther. USNM No. 110664, Guanajuato, Guanajuato (*maculatus* type).

FIG. 4. *Conopsis nasus* Günther. USNM No. 110665, Guanajuato, Guanajuato (*maculatus* type).

Plate XXXII

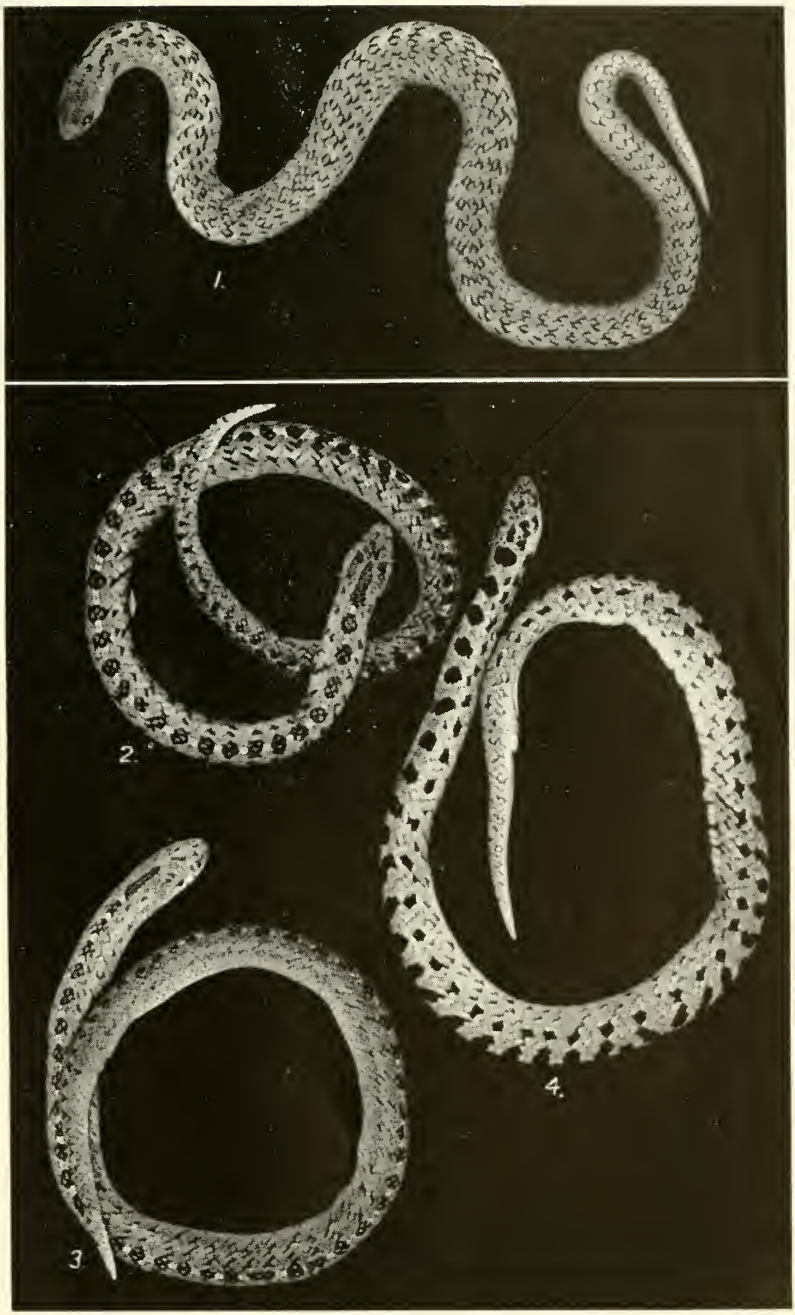


Plate XXXIII

FIG. 1. *Toluca lineata acuta* (Cope). EHT-HMS No. 16193, Tepeyahualco, Puebla.

FIG. 2. *Toluca lineata acuta* (Cope). USNM No. 110762, Cacaloapan, Puebla.

FIG. 3. *Toluca lineata acuta* (Cope). EHT-HMS No. 16188, Cacaloapan, Puebla.

FIG. 4. *Toluca lineata acuta* (Cope). EHT-HMS No. 5315, near Cacaloapan, Puebla.

FIG. 5. *Toluca lineata acuta* (Cope). EHT-HMS No. 5314, near Cacaloapan, Puebla.

FIG. 6. *Toluca lineata acuta* (Cope). EHT-HMS No. 5318, near Cacaloapan, Puebla.

Plate XXXIII

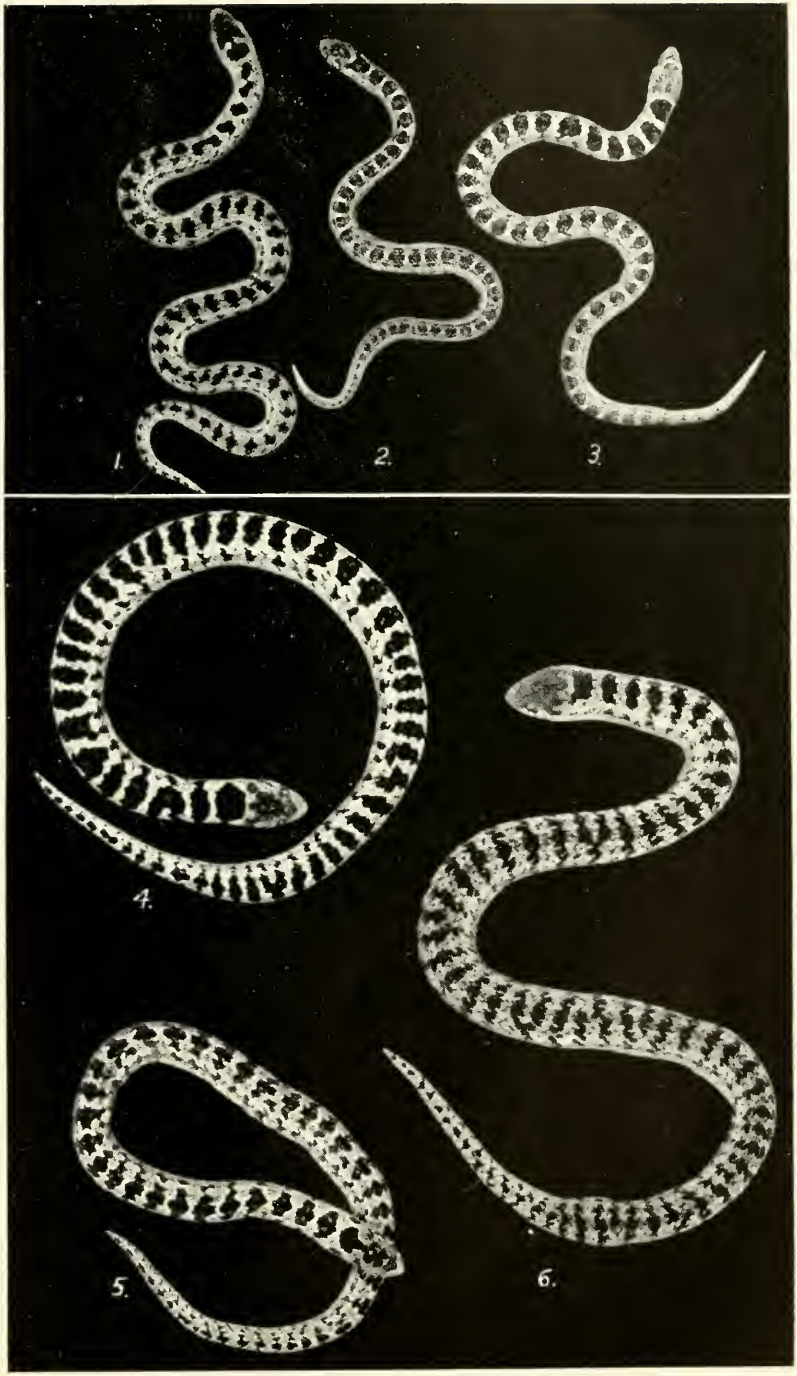


Plate XXXIV

FIG. 1. *Toluca conica* sp. nov. Paratype, MCZ No. 42654, "Omilteme and Sierra de Burro," Guerrero.

FIG. 2. *Toluca lineata lineata* Kennicott (reddish phase). UMMZ No. 56485, Velasco, Hidalgo.

FIG. 3. *Toluca lineata varians* (Jan) (reddish phase). EHT-HMS No. 4748, near Acultzingo, Veracruz.

FIG. 4. *Toluca lineata lineata* Kennicott. EHT-HMS No. 4704, 9 miles N. W. Toluca, México.

FIG. 5. *Toluca lineata lineata* Kennicott. EHT-HMS No. 4704A, 9 miles N. W. Toluca, México.

Plate XXXIV

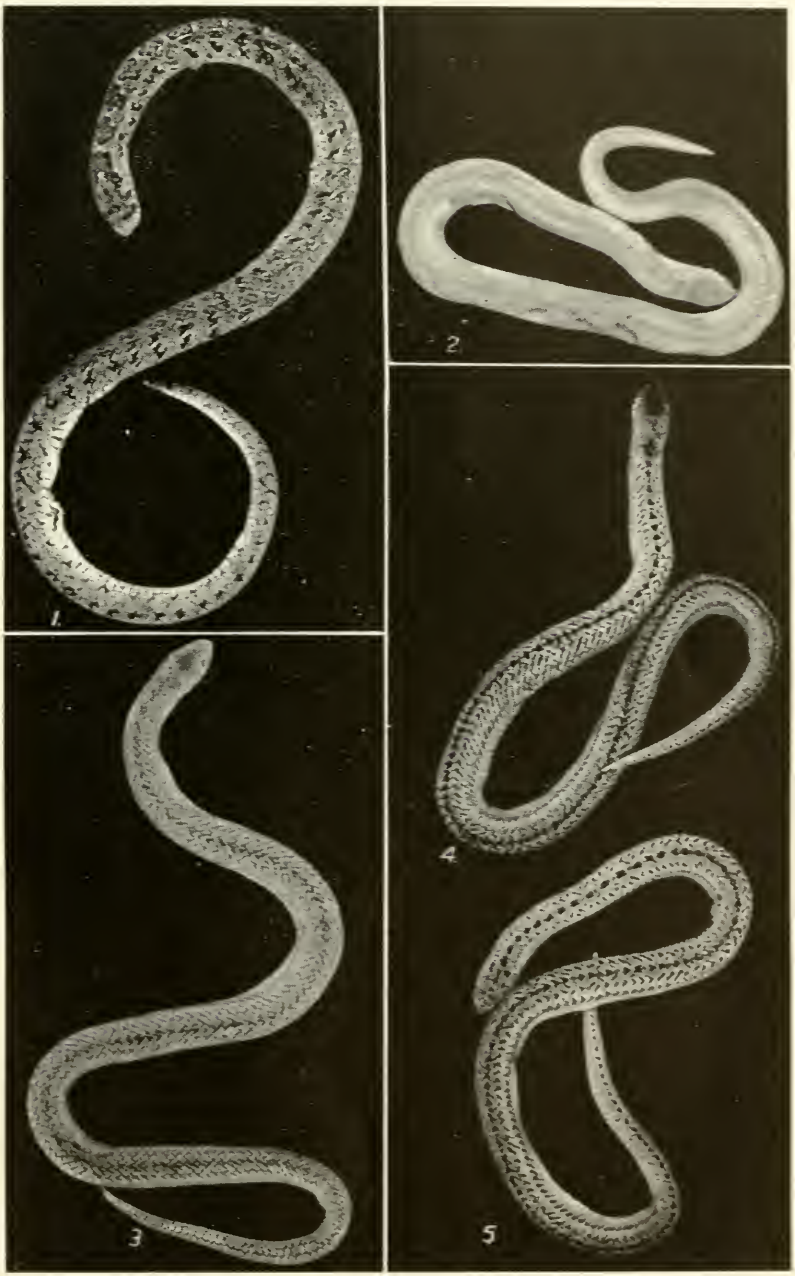


Plate XXXV

FIG. 1. *Toluca megalodon* sp. nov. EHT-HMS No. 23640. Summit Cerro San Felipe, near Oaxaca, Oaxaca. Maxilla (right), enlarged.

FIG. 2. *Toluca lineata varians?* EHT-HMS No. 23637, Cacaloapan, Puebla (referred with some doubt). Maxilla, enlarged.

FIG. 3. *Toluca lineata lineata* Kennicott. UMMZ No. 89368B, Río Frío, México. Maxilla, enlarged.

FIG. 4. *Conopsis nasus* Günther. Uncertain locality (probably near Lake Pátzcuaro). Maxilla, enlarged.

FIG. 5. *Conopsis nasus* Günther. EHT-HMS No. 16183, 5 miles East of Lake Pátzcuaro, Michoacán. Maxilla, enlarged.

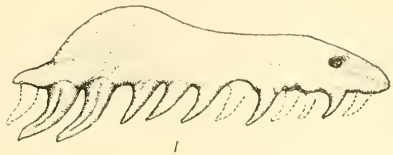
FIG. 6. *Toluca sp.* EHT-HMS No. 23641, at foot of Cerro San Felipe, near Oaxaca, Oaxaca. Maxilla, enlarged.

FIG. 7. *Toluca lineata lineata* Kennicott. EHT-HMS No. 23643, by Lake Zempoala, Morelos. Maxilla, enlarged.

FIG. 8. *Toluca lineata lineata* Kennicott. USNM No. 2104, paratype of *Toluca lineata* Kennicott. Maxilla, enlarged.

FIG. 9. *Conopsis biscrialis* sp. nov. Type, EHT-HMS No. 23648, 10 miles west Villa Victoria, México. Maxilla, enlarged.

Plate XXXV



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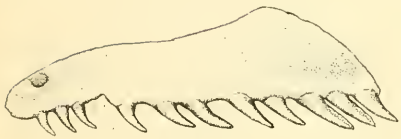

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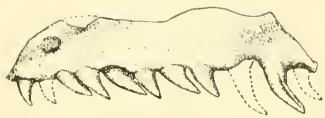

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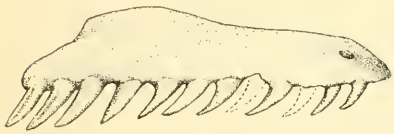

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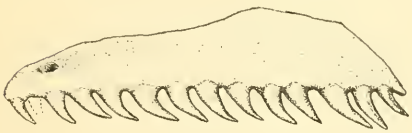

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V.....Nos. 1-11, weight, 33 ounces. Nos. 12-21, weight, 27 ounces.

VI.....No. 1, weight, 27 ounces. Nos. 2-7, weight, 19 ounces.

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X.....Nos. 1-15, weight, 17 ounces.

XI.....No. 1, weight, 20 ounces.

XII.....Nos. 1-2, weight, 19 ounces.

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XIV.....Nos. 1-21, weight, 34 ounces.

XV.....Nos. 1-6, weight, 18 ounces.

XVI.....Nos. 1-6, weight, 14 ounces.

XVII.....Pt. I, No. 1, weight, 18 ounces. Pt. II, Nos. 2-7, weight, 8 ounces.

XVIII.....Nos. 1-13, weight, 38 ounces.

XIX.....Pt. I, Nos. 1-7, weight, 6 ounces. Pt. II, Nos. 8-14, weight, 16 ounces.

XX.....Pt. I, Nos. 1-6, weight, 11 ounces. Pt. II, Nos. 7-21, weight, 15 ounces.

XXI.....Nos. 1-16, weight, 32 ounces.

XXII.....Nos. 1-18, weight, 32 ounces.

XXIII.....No. 1, weight, 40 ounces.

XXIV.....Nos. 1-21, weight, 38 ounces.

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